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Economic Returns of Vertisol Innovation: An Empirical Analysis of Smallholders Mixed Farming in the Highlands of Ethiopia

Gezahegn Ayele and Franz Heidhues*

Abstract

Vertisols are significant soils ,which support the majority of livestock and human population in the highlands of Ethiopia. Waterlogging of Vertisols and drainage problems are one of the major problem hindering the workability and the potential of the soils. Packages of Vertisol technology which includes the Broad Bed Maker (BBM), crop variety and dry planting was developed by the Joint Vertisol Project (JVP) team of Ethiopia to ammeliorate the problem. This study was conducted with the broad objective of assessing the profitability and the consequent economic returns from adopting the technology. Both on-farm and household level analysis indicated that the vertisol technology is cost-effective and economically sound. This was verified through marginal analysis and Policy analysis matrix (PAM) of Domestic resource cost comparison and other indicators. The results of the marginal analysis indicated that a marginal increment of close to 300% and 200% for an on-farm and household level respectively can be derived from the use of package of the technology. Although inter-farm variability due to many factors is inevitable, the DRC result confirms, that much more comparative advantages can be gained from the packages of vertisol technology than the traditional practices of the farmer. Apparently, there is an evidence of clear difference observed between on-farm and household level performance owing to mainly the difference in the level of management. The sensitivity result confirms also the performance of the technology can be improved if support policy measures are taken into consideration. In addition the environmental impact of soil conservation is another dimension of advantage that should be considered as positive attribute to the technology.

1 Background

Vertisols make up a significant proportion of African soil, covering about 85 million hectares in sub-Saharan Africa of which 13 million hectares are found in Ethiopia. Of the 13 million hectares, 7.6 million are found in the central highlands and 5 million in the lowlands (Berhanu, 1986). The highland covers 40% of the land mass but account for about 95% of all cultivated land, comprising of 88% of the total human population

* Institute for Agricultural Economics and Social Sciences in the Tropics and Subtropics, University of Hohenheim, 70593 Stuttgart

and 70% of the total livestock population. It is estimated that, over 90% of the economic activities is by far concentrated in these areas (Constable,1984). Nevertheless close to only 28% of the highlands vertisols are cultivated, generally with low yielding food crops that are planted during the latter part of the growing season.

The characteristics of vertisols farming are such that they are hard when dry and sticky when wet. Waterlogging of vertisols and drainage problem is more severe in the Ethiopian highlands where rainfall is higher and evaporative capacity are lower (Haque *et al.*,1993). The traditional farming has developed a wide range of drainage practices, such as construction of hand made broadbed and furrows in the central plateaux, planting in ridges, soil burning etc, and the use of low yielding crop varieties and late planting practices to avoid water logging problem.

However, using only part of the growing season leads to the loss of grain yield as well as crop residues. As a result, the crop residue available at the end of the growing season would be small in quantity and hence the large number of livestock population supported in these Vertisols area suffer from energy shortages during most of the year (Abiye,1993). The observation is that with the exception of hand made broadbeds and furrows the technical efficiency of the traditionally applied surface drainage techniques is not sufficient to allow full use of the potentials of the soils (Mesfin,1982, Jutzi et al., 1987)

The experience of ICRISAT with the use of vertisols in semi-arid India indicates that the key to drastically improving the productivity of vertisols is effective control of surface soil water which then enables rational use of the land for food and feed production (Bull, 1988). As a result, the potential and awareness of the technology for the improvement of vertisol led to a collaborative effort of joint vertisol project (JVP) to develop packages of agricultural technology in Ethiopia. In view of this the JVP has developed packages of vertisol technology for raising the productivity of vertisols which combines Broad Bed Maker (BBM), better cropping options and technologies for dry planting based on local practices of the farmers (Getachew *et al.*, 1993). The BBM is thought to be an effective low cost animal drawn plough to increase drainage more efficiently than traditional hand method *maresha* in order to exploit the productive potential of the vertisols. On-farm research results indicated that in some cases crop yields can be increased as much as 60% through drainage improvement by BBM method. However by adopting packages, crop yield can be raised two-fold or even more (Tekalign et al., 1993). It was also reported that the use of BBM has replaced the drudgery of manual BBF construction, thus increasing human welfare specially for women.

The advantages of using the Vertisol technology has attracted the attention of policy makers in the country. International institutions such as Global 2000 are taking part in promoting the technology to the smallholders in the highlands of Ethiopia. Consequently adoption of the Vertisol innovation for a better management of Vertisol became a desirable intervention to curb food shortages in the Ethiopian highlands.

However the Vertisol technology being a new innovation would be affected by a number factors for a wider adoption by the smallholders in Ethiopia. As a result the contribution of the technology may diverge from the potential. The multitudes of factors affecting the performance of the technology at smallholders levels can be explained through many interconnected subsystems of vertisol related resource utilisation. Such as interaction between crops and animals, energy and nutrient flows, economic transaction and interaction at farm level and farm's external environment. Policy environment (price policy, subsidy tax, credit etc.) affects the performance of the technology..

Although many on-farm studies of biological and technical nature have indicated clearly the benefits of adopting the packages of the Vertisol technology, no study was found to have adequately analysed the performance of the vertisol technology and the gains to smallholder farming in Ethiopia. In line with this background, the overall objective of this study is to determine the relative profitability of the vertisol innovation and its implication for smallholder farming in Ethiopia.

2 Methodology

2.1 Data sources

The proposed study was based on both primary and secondary sources of data. The survey results of 1996/97 at the household level whose main products are wheat, chickpea and Lentil are used for the Policy Analysis Matrix (PAM) and marginal analysis. The data were collected from two vertisol areas of Tullubollo and Gimbichu where the technology has been long disseminated. The type of data collected include all sorts of technical and economic data. Detailed data collection include on input-output (labour, number of oxen, land holding, fertiliser use, grain yield, straw yield) and the corresponding values. Key factors taken in an on-farm analysis are input output data collected from on-farm trials based on farmers actual operation. To reflect farmers situation the yield has been adjusted down ward by 15% following CIMMYT'S approach. The data set are costs of farm input, labour use, land ,fertiliser, BBM, oxen, the yield (grain and straw) with corresponding values. In addition off-farm costs have been added in the form of field costs which include transport cost, collection costs, storage costs and handling costs. The crops considered at on-farm level are Wheat, Chickpea , and Lentils. But at the household level only wheat was considered for wheat being the only variety included in the package during the period under consideration.

Secondary sources of data from on-farm trials of JVP sites and published and non published data sources as well as some biological data were summarised as a prelude to the analysis to be conducted.

2.2 *Method of analysis*

Marginal analysis and policy analysis Matrix (PAM) were employed to see the economic performance of the profitability of the technology. The PAM uses the concept of profit as its main point of analysis and the cost and return structures are presented in the form of a matrix which allows for easy presentation and interpretation of results (Table 1) .The four indicators of PAM used in this paper are Nominal Protection coefficients (NPC), Domestic Resource Cost (DRC), Effective Protection Coefficients (EPC) and both financial and social profitability. For the description and analysis of the data simple descriptive statistics (ratios, mean, standard deviation) were employed.

Based on the approach of PAM cost and returns were desegregated both at market and social values and domestic resource efficiency was provided by the Domestic Resource Costs (DRC). DRC is an indicator of the total cost of production when prices are adjusted for taxes, subsidies and market imperfections and resources valued at their opportunity costs. In valuing social and tradable inputs their opportunity cost is estimated by the world or border price which is CIF price adjusted for transport and administrative costs. For the non-tradable inputs including some of the domestic factors of production the Standard Conversion Factor (SCF) has been employed to value the respective social opportunity costs. The use of a DRC approach in determining the potential contribution of a given technology in a given farming system is well documented by Byerlee and Longamire (1986). An activity is said to have a comparative advantage, when the DRC ratio is greater than zero but less than one.

Table 1: Policy Analysis Matrix (PAM)

Value/ton of Commodity	Revenues	Costs of both		Profits
		Tradable inputs	Domestic Factors	
Private values	A	B	C	D1
Social values	E	F	G	H2
divergences	I3	J4	K5	L6
1. Private profits (D)= A-(B+C)				
2. Social profits (H) =E-(F+G)				
3. Output divergences (I)= A-E				
4. Input divergence (J) =B-F				
5. Factor divergences (K) = C-G)				
6. Net divergences (L) = D-H= I-(J+k)				
A. : Domestic Resource Cost Ratio(DRC)= G/(E-F)				
B. Nominal Protection Coefficients (NPC)= B/F				
C. Effective Protection Coefficients (EPC)= (A-B)/(E-F)				

Source : Monke and Pearson (1989)

3 Results of the Analysis

3.1 Marginal Analysis

3.1.1 On-farm level

The farming system perspective which is more of farmers participatory approach was followed to conduct on-farm trial. It is more appropriate to consider marginal analysis in an on-farm evaluation of a given technology. The marginal rate of return (MRR) or the marginal benefit increment is a suitable criterion to evaluate profitability and viability of an improved technology. It calculates the additional returns from additional operational costs (M.Von Oppen et al, 1986). Although a certain minimum of advantages can be gained from using partial BBM technology, greater benefits can be acquired from using Packages of the Vertisol technology.

Table 2 presents the on-farm trial evaluation of improved vertisol management which yields better Marginal rate of return (MRR) or marginal benefit increment. The improved technology performed better than the local with a Marginal benefit increment of more than 300% for wheat in Ginchi. Any additional cost to the optimum level of the technology per hectare generates additional incremental returns to the farmer on investment in Vertisol technology. The broad bed and furrows (BBF) constructed with the animal drawn implement known as broad bed maker (BBM) showed that both seed and straw yields of wheat can be increased in the two areas mentioned . Similar analysis also holds true for chickpea and Lentil. The BBM has a return to labour which means more labour can be saved by adopting the technology. It also reduces drudgery of manual labour.

Table 2: On-farm profitability of crops at various locations of the Vertisols

	Gross margin (EB*/ha)	Net gain (EB/ha)	MRR %
Inewari			
Improved management:			
Wheat	789,00	468,00	
Traditional management			
Wheat	537,00	288,00	134,00
Chickpea	432,00	239,00	92,00
Ginchi			
Improved management:			
wheat	1.214,00	976,00	
Traditional management			
Wheat	536,00	337,00	313,00
Chickpea	532,00	355,00	218,00

EB*=Ethiopian Birr, USD=6,50 ETB at the time of the surveys

Studies conducted on Chickpea and Lentil on farmer's field revealed that the use of BBF has increased the grain and straw yield of the crop significantly. Grain yield increment of 120% and 94% at Akaki, Ketebe respectively was obtained by using Broad-Bed and furrow method as compared with traditional farmers practice of flat planting late in the season. The result of marginal analysis on the BBF method of seed bed preparation (drainage method) using BBM under the given price and environmental situation resulted in an acceptable marginal benefit increment of 208% for investment in the use of BBM (Table 3).

3.1.2 Household level

The marginal rate of return in the form of net benefit increment at the household level was calculated on the basis of sampled farmers (n=52) aggregated from the study areas (Table 4). The household level analysis demonstrated a spectacular increase of yield as the result of dry planting as compared to traditional wet season planting. This results confirms that there is a marked marginal increment from the use of BBM technology. Although there seems to be variability in the average yield obtained from the use of BBM technology, the overall yield increment is more than almost doubled over the traditional one on the same soil type. The variability of output on the same soil could be attributed to different level of efficiency in attaining drainage which in turn depends on skill of individual farmer in making use of BBM. In addition to this the optimum time of using the implement determines the efficiency of the BBM in draining the excess water. Technically the advance of sowing date permits the use of soil moisture and better nutrient utilisation. This provides for the soil an early crop cover which substantially reduces soil erosion. The benefits gained can be viewed in twofold perspective; in

Table 3: On-farm marginal analysis of BBF method for Chickpea Akaki and Keteba areas of three years of average results.(1990-1993)

	BBM	**Traditional**
Grain yield kg/ha	2101	1021
Straw yield kg/ha	3105	1743
Adjusted grain yield kg	1849	894
Adjusted straw yield	2732	1534
Gross field benefit	1294	632.51
Total cost that vary		
(labour, implements)	224.85	9.53
Net benefit	1070.11	623.08
Marginal rate of increment %	208	
Field prices used	Grain	0.64 birr/kg
	Straw	.03 birr/kg
	Labour	4.00 birr/manday
	Depreciation BBM	0.80 Birr/day
	Rental service, ox	2.00 birr

Depreciation BBM 0.80 Birr/day Rental service, ox 2.00 birr **Source:** on -farm data collection terms of environmental impact and economic benefit gained which can be assessed in terms of Net benefit increment.

3.2 *PAM analysis of revenue and Profit divergence*

3.2.1 *On-farm level*

Like the marginal analysis the economic analysis using PAM is carried out at two levels i.e. on-farm and household level. On-farm trial is normally carried out with more of farmers participation with researchers' management, while household level is controlled and carried out solely by the farmers.

The private cost budgets estimated for the three groups of commodities were placed in the PAM framework, along with social budgets calculated as described in the methodology section. Each type of divergence between social and private values was identified early in the budgeting process and tracked through the budget calculations as to avoid the underestimation/overestimation in the data set.

Table 5 compares private and social revenues, costs and profits for the three groups of crops Both private and social profitability tend to be positive for all the commodity groups under consideration. Wheat commands the highest social profitability among the groups considered. The social profit is greater than the private profit (3398 as against 4254). This holds true also for Chickpea and Lentil under BBM (Table 5). The advantage of a BBM technology can clearly be seen from the high rate of return on the investment. It amounts in some cases (wheat) as much as 200% on the Ethiopian highlands of vertisol areas.

Table 4: Household level Marginal analysis of BBM wheat production on the vertisols

Cost items (EB*)	Improved (BBM)	Traditional
Average yield	2,4t/ha	1t/ha
Aver. producer price	120/t	120/t
Gross Margin	2400	1200
Variable Costs		
Labour	535	565
Material Cost		
Seed	350	262
DAP	175	80
Urea	240	110
Depreciation BBM	-60*	
Total cost	1371	980
Net returns	1029	220
Marginal cost due to BBM	391	
Marginal revenue to BBM	809	
Cost Benefit ratio	2.07	

* Ethiopian Birr(EB) 1US=6,50 EB *Source:* Own survey

Table 6 presents and compares the comparative advantage indicators of PAM. The over all result for the commodity group namely: wheat, chickpea and lentil have shown that the domestic production has comparative advantage. This result has been compared among BBM technology and traditional Practices of the farmer. The traditional practice has got clearly less comparative advantage compared with the BBM technology. This is evidenced by the level of DRC indicators lying between one and zero and followed by relatively higher magnitude of financial and economic returns. The DRC results show domestic resource efficiency under social pricing with DRC ratios of 0.17, 0.60 and 0.15 for wheat, chickpea and Lentil respectively. This analysis further confirms that, the production of the crops under BBM condition has got more comparative advantage than traditional practices of the farmer and proved to have efficient use of domestic factors, a result driven by high returns to factors under social valuation. The overall average DRC result for the three commodity groups is 0.28, indicating the clear comparative advantage of production the crops have with respect to world markets, given current technology and input prices.

Table 5: PAM results of profitability for the major crops under vertisol (EB/ha)

Commodity	Revenues		Costs(EB/ha)		Profits (EB/ha)	
	private	social	private	social	private	social
Wheat BBM	3.398,00	4.258,00	1.469,00	2.011,00	1.925,00	2.243,00
Wheat tradition	2.408,00	3.068,00	1.313,00	710,00	1.095,00	1.339,00
Chickpea BBM	3.306,00	3.726,00	948,00	1.457,00	2.358,00	2.269,00
Chickpea traditional	1.618,00	1.822,00	900,00	1.390,00	718,00	432,00
Lentil BBM	4.125,00	3.872,00	910,00	1.435,00	3.215,00	2.437,00
Lentil traditional	2.299,00	2.161,00	832,00	1.032,00	1.467,00	1.129,00

EB= Ethiopian Birr, 1USD= 6,50EB at the time of the survey **Source**: Calculated from on-farm budget data

Table 6: Summary of PAM indicators

Indicators	Wheat		Chickpea		Lentil	
	BBM	local	BBM	local	local	BBM
DRC	0.17	0.21	0.60	0.29	0.15	0.19
NPC	0.86	0.21	1.03	1.6	1.31	1.3
EPC	0.94	0.88	1.05	2.1	1.33	1.33

On the other hand, at all level s of the production system, NPC ranges from 0.21 to 1.03. It appears that several constraints are being imposed on the production of wheat while Lentil and Chickpea are relatively protected by policy. Apparently there seems to be implicit subsidy on the production of chickpea and Lentil. Although wheat is subsidised on its tradable input of fertiliser , the net tax effect on its value added is more than outweighs the subsidy (EPC<1). These results are provided by the Net Protection coefficient (NPC) and Effective protection coefficients (EPC). Under such argument , the protection of Lentil and Chickpea enjoy up to 10% and 33% subsidy respectively on their value added.

Such divergence between market values and social values can be explained by the market distortion mainly caused through the government intervention. The result has been further confirmed by the negative values of the tradable.

3.3 Household-level analysis

The PAM analysis was carried out at the household level only for wheat production for wheat was the only available package component at the time of the survey. Although there is somewhat crop diversity in the area wheat remains to be still amongst the important cereal crops grown in the area. Other crops especially pulses were considered to be minor crops and thus grown during dry season only after the harvest of major cereals. There is as well the scarcity of improved seeds and land.

Like the earlier indicators of on-farm level analysis, DRC ratio lies below 1 indicating. a comparative advantage of producing wheat for the farmers in the area. The Social profitability indicates higher magnitude of profitability can be obtained in producing wheat under improved technology (Table 7). Nevertheless, it can be verified further that net profit accrues to the BBM technology varies from farm to farm at the same location depending on the efficiency and adoption level of the technology. On the other hand, although the value of EPC is less than one, is close to one implying less protection to wheat production under BBM condition.

Table 7: Efficiency indicators of wheat Production under Vertisol condition

	Wheat		NSP		DRC		NPC		EPC	
			BBM	local	BBM	local	BBM	local	BBM	local
Mean			2575	433*	0.13	0.36**	0.78	0.31***	0.78	1.6**
S.D.			301	828	0.54	0.01	0.35	0.88	0.66	1.29

*,**,*** significant at 1, 5, 10% respectively.

All the foregoing efficiency indicators have been worked out for random variables of which some were collected from farm level and some of them from secondary sources. Nevertheless , they vary across site and year. Prices are also varying across season in many locations. Taking the indicators as a guide for policy analysis as they stand would lead to erroneous conclusions of practical importance.

It is therefore worthwhile to consider the variability and the comparability of the technology using significant tests. The statistical significance of comparison of NSP and NPC to zero and of DRC and EPC to unity are accomplished with t-test. This comparison consists of mean of NSP, EPC, DRC and NPC between technological option of BBM and local technology. Consequently , the t-test conducted showed that there is significant difference between local and BBM technology at 1%, 5% and 10% level.

3.4 Sensitivity Analysis

DRC ratios and subsequent PAM results are sensitive to the yield levels, reference price levels of the commodity in question, wage and exchange rates. Although it may be difficult to handle all the parameters simultaneously, changes in these indicators can be increased by reporting their sensitivity to component variables, by computing elasticities. Often elasticities are sensitive to the sample means at which they are computed and thus the problem of statistical confidence remains (McNTIRE AND DEGALDO, 1985). DRCs are moderately elastic (0,15 to 0,70) to the world price change both for traditional and BBM technology. Relatively highest response was observed for Lentil with elasticity of 0,18 to 0,70. This indicates that the pulse group has better connection with the external market. Indicators of NPC and EPC seem to be highly elastic (1 to 1,4) nearly for all the crops. Apparently DRCs are less elastic with regard to domestic prices of inputs but moderately elastic to NPC and EPC.

Table 8: Sensitivity of indicators with respect to parameter changes (elasticities of indicators)

Scenarios	Indicators	Wheat		Chickpea		Lentil	
		BBM	Trad	BBM	Trad	BBM	Trad
Decrease 10% World price of output	DRC	0.25	0.15	0.39	0.26	0.15	0.7
	NPC	1.2	1.05	1.1	1.1	1.2	1.3
	EPC	1.5	1.1	1.2	1.0	1.3	1.4
Yield increase by 30%	DRC	0.15	0.17	0.16	0.18	0.11	0.11
	NPC	1.0	1.3	0.88	0.87	1.0	1.11
	EPC	1.1	1.4	0.88	0.88	1.1	1.11
Price of input increase by 10%	DRC	0.22	0.15	0.35	0.24	0.12	0.15
	NPC	1.05	1.0	0.88	0.86	1.0	1.1
	EPC	1.1	1.1	0.88	0.85	1.1	1.2
Yield decline by 20%*	DRC	0.26	0.15	0.35	0.30	0.30	0.21
	NPC	1.08	1.07	0.88	0.85	1.2	1.17
	EPC	1.34	1.1	0.88	0.84	1.33	1.2

*30% is assumed for Lentil production

Source: calculated based on earlier assumptions as given in the previous tables.

Under such consideration, the effect of yield increase across all the commodity group has improved the DRC ratio and lead to a marked increase in profitability (Table 7). The assumption is that, BBM use would lead to exploit the potential of the land under vertisol while in the case of local practice, improved management will lead to higher yield.

DRC ratios are also sensitive to yield loss or yield reduction. Unlike yield increase it was assumed that, different levels of yield loss would persist for the three commodities according to researchers recommendation. A 20% and a 10% yield loss of wheat BBM and wheat traditional respectively, resulted in a DRC ratio of relatively higher level. Reasonably a higher magnitude of loss would be expected from pulse group than cereal group mainly because of risk. With a yield loss of 20% for BBM chickpea and chickpea traditional practice respectively increased the DRC ratio and consequently reduced the competitiveness of the crop. Relatively higher magnitude of yield loss has been considered for lentil production. Although, it appears to be substantial increase in DRC ratio and less profitability, still under high risk condition, the production of lentil seems to be a profitable venture. Similarly, sensitivity analysis assuming, increase in input price and the reduction of world price has been conducted. The DRC ratio increased exhibiting that the competitiveness of the crops will decrease under the assumption of the two scenarios.

In general production of wheat, chickpea and lentil have got more comparative advantages under BBM technology and should be promoted. However, the analysis of comparative advantage should go beyond DRC analysis thereby considering acceptability and other social parameters of the given farming system which may not be easily justified through DRC ratios. In-depth treatment of such an issue should be considered in another studies.

4 Conclusions

The challenges of the vertisol and its potential contribution towards the majority of Ethiopian highland population can be tackled through innovation. The vertisol innovation developed by the Joint Vertisol Project (JVP) team helps to tackle some of the serious constraints facing the smallholders in the highlands of Ethiopia. The innovation is:

a) leading to increased food crop production and crop residue thereby enabling to ex ploit the potentials of the soils,

b) technology that saves labour as compared to the traditional method and avoids drudgery of manual labour and

c) economically attractive, that the smallholders can afford to invest on it.

Nevertheless, to fully exploit and sustain the contribution of the technology towards food crop production without damaging the environment, it should be synchronised with other policy support measures. To this effect policies geared towards price, credit, banking, and other infrastructure and similar incentive measure would help towards promoting the technology.

Ökonomischer Nutzen der Vertisolinnovation: Eine empirische Analyse von kleinbäuerlicher Landwirtschaft im Hochland von Äthiopien

Zusammenfassung

Vertisole nehmen in Äthiopien eine Fläche von 12,7 Millionen Hektar ein. Davon liegen 7,6 Millionen Hektar im Hochland. Verisole sind fruchtbare Böden aber schwer zu bewirtschaften. Im trockenen Zustand sind sie im allgemeinen hart und sie bekommen eine plastische Konsistenz, wenn sie feucht werden. Diese Bodeneigenschaften von Vertisolen schränken erheblich ihre Nutzung ein. Dennoch ist die Mehrheit der Bevölkerung und der Schwerpunkt der Viehhaltung im Hochland von Äthiopien auf Vertisolen angesiedelt. Ein interdisziplinäres Team entwickelte im Rahmen des „Gemeinsamen Verisol Projektes (GVP)“ in Äthiopien ein Innovationspaket einer Vertisol Technologie zur Überwindung der Probleme. Dieses Paket beinhaltet ein Gerät zur Saatbettbereitung (BBM), bessere Anbauverfahren und eine Technik zur Trockensaat. Die vorliegende Arbeit wurde im Zentralen Hochland durchgeführt und hat zum Ziel, die Wirtschaftlichkeit des BBM-Technologiepaketes sowie seine Verbreitung zu untersuchen. Die Untersuchung stützt sich sowohl auf Primär- als auch auf Sekundärdaten.

Sowohl Betriebserhebungen und Studien auf Mikroebene als auch Sekundärdaten zeigen, daß die wirtschaftlichen Erlöse im Vergleich zu den traditionellen Techniken der Bauern durch den Einsatz der Technologie deutlich gestiegen sind. So konnte eine Erhöhung der Erlöse bis zu 200-300% für das Innovationspaket gegenüber der traditionellen Technologie gefunden werden. Sowohl die Kosten-Nutzen-Analyse als auch die Berechnung der Domestic Cost Ratios (DRCs) wurden angewandt, um die betriebliche Leistung der Innovation zu untersuchen. Aufgrund vieler Faktoren ist eine Variabilität zwischen den Betrieben unvermeidbar. Dennoch verdeutlichen die Ergebnisse der DRC, daß signifikante komparative Vorteile gegenüber den traditionellen Techniken durch die Akzeptanz der Vertisol Technologie erzielt werden können. Zusätzlich ermöglicht die Vertisol Technologie einen positiven aber nicht quantifizierbaren Nutzen durch ihre bodenkonsenrvierende Umweltwirkung. Der Beitrag endet mit einer Analyse der institutionellen und agrarpolitischen Maßnahmen die für eine größere Verbreitung und Akzeptanz erforderlich sind.

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