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EXECUTIVE SUMMARY

The experiments with African state-led models of input intensification on food crops (featuring subsidized state credit disbursement, input delivery, and purchase of output) generally have proven themselves to be financially unsustainable. But in many parts of Eastern and Southern Africa, the subsequent withdrawal of state-subsidized credit, input delivery and food crop price fixing has resulted in a decline of cash inputs on food crops. A sustained renewal of African agriculture growth will require some form of transformation out of the semi-subsistence, low-input, low-productivity farming systems that currently characterize much of rural Africa.

High-valued cash crops represent one potential avenue of crop intensification. But the case for cash cropping has generally been based on the direct contribution that *these crops* can have on farm incomes. A relatively neglected avenue of research concerns the effects that cash cropping can have on the productivity of other household activities, including food crop cultivation. This paper examines two potential pathways by which cash cropping may affect the productivity of other crops: (1) *household-level synergies* (which occur when the household's participation in a commercialized crop scheme enables it to acquire resources not otherwise available for use on other enterprises in the crop mix); and (2) and *regional spillover effects* (which occur when a commercialization scheme may attract certain kinds of investments to a region which create spillover benefits to farmers engaged in other crops). Examples of these *household-level* and *regional-level spillover effects* include:

1. Under credit and input market failures, commercialization schemes may be one of the few feasible ways to acquire credit and inputs. In some cases, through interlinked transactions for inputs, credit, management, and sale of products, the institutional mechanisms between farmers and marketing firms can relieve some of the market failure problems that constrain input intensification on grain crops. The success and sustain ability of this pathway may depend on the firm's ability to recover its credit and associated costs of supporting smallholder production.

2. Input-intensive cash crops, by promoting market demand for inputs, may induce private sector investment that improves the availability (and reduces per unit costs) of key inputs that can be used on a wide range of crops.

3. The promotion of high-value, high-return enterprises may improve households' ability to invest in lumpy assets such as animal traction.

4. Commercialization may support private investment in infrastructure and human capital that has broader benefits for other economic activities such as food crop production.

These potential synergies between cash crops and food crops have been generally neglected in food crop research and extension programs, although they may have important implications for programs designed to promote smallholder food crop productivity growth. More comprehensive information on the interactions between food and cash crop production may help in

understanding the indirect payoffs to cash crop research programs and in refining extension strategies designed to promote food crop productivity.

This paper studies the dynamics between cash cropping and food crop productivity in Gokwe North District in Zimbabwe, a major cotton producing area. The main research issues were: (1) to identify the determinants of commercialized crop production at the household level; and (2) to determine the effect of increasing crop commercialization on household food productivity. The paper derives a *household crop commercialization index*, defined as the ratio of crop sales to total crop production. We develop econometric models for identifying the determinants of household-level commercialization and for measuring its effects on food crop productivity. Results are based on cross-sectional household survey data collected in 1996, implemented under the project on Integrated Assessment of Trypanosomosis Control Strategies and their Impacts. This project is a joint collaboration between International Livestock Research Institute (ILRI), University of Zimbabwe (UZ), Regional Tsetse and Trypanosomosis Control Program (RTTCP) and the Department of Veterinary Services Tsetse Control Branch of Zimbabwe.

The principal findings of the paper are:

1. This area of Zimbabwe is highly commercialized in cotton production. Maize accounts for 47.4% of cropped area, while cotton accounted for 45.2%. However, there are clear differences in the purposes for growing these crops: 100% of the cotton production was marketed, while 93.8% of maize production was grown for home consumption. Cotton sales contributed 83.6% of the value of marketed crop income. In this area of Zimbabwe, agricultural commercialization is virtually synonymous with expanding cotton cultivation.

2. Especially under conditions of credit and input rental market failures, cash cropping schemes may enable households to increase both input use and productivity of food crops. Cotton commercialization at the household level significantly and positively affected food crop productivity, *ceteris paribus*. The expected value of food grain output for households at the mean level of cotton commercialization was 38.1% higher per hectare of food crops than households growing no cotton. Also gross crop income per hectare and per family member were positively related to the share of cotton in cropped cultivation.

3. Traction equipment and draft power were found to be key determinants of households' ability to diversify into cotton production. Under the relatively land-abundant conditions of the study area, animal traction allows households to put more land under cultivation, and therefore is a major source of increased farm production per capita.

4. Cotton commercialization was significantly positively affected by farm size, other factors held constant, but farm size was significantly inversely related to food crop productivity.

5. The level of education, maturity of the household head and the household's investment in animal traction significantly and positively affected food crop productivity.

6. The degree of cotton commercialization varied significantly across locations at various stages of settlement development. The development stages for the settlements were driven by the relative timing of tsetse control.

Overall, the findings show that farm dynamics between cash cropping, capital investment, and food crop productivity are important to consider in discussions of agricultural commercialization among smallholder farmers.

Most local and internationally-based agricultural research programs designed to promote food crop productivity growth in Africa are based on the allocation of scarce resources to primary food crops. To a large extent, agricultural and nutrition policies in Zimbabwe have historically formulated rural development strategies on this conventional wisdom and have implicitly or sometimes explicitly regarded diversification into non-food cash crops as detrimental to household food security objectives. While productivity growth of staple food crops is indeed essential to overall rural productivity growth given the large proportion of cropped area under food crops, the potential of higher-valued cash crops to promote food crop productivity has often been neglected.

The challenge for government policy is to identify and facilitate strategic pathways to create positive interactions between food and cash crops, and between the public and private sector. The various pathways, by which crop commercialization can affect food security and incomes under conditions of pervasive market failures, need to be more clearly understood to develop more informed policies in support of smallholder welfare. This study suggests that, despite frequent criticisms stressing the trade-offs between agricultural commercialization and food crop production, it is important to also consider the potential synergies.

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1. INTRODUCTION

Meeting the challenge of improving rural incomes in Africa will require some form of transformation out of the semi-subsistence, low-input, and low-productivity farming systems that currently characterize much of rural Africa. In some areas of Eastern and Southern Africa, input intensification was formerly promoted on food crops through state-led programs featuring subsidized credit and input delivery programs and fixed commodity prices implemented by state marketing boards (Rohrbach 1988; Byerlee and Eicher 1997). However, these policies eventually accumulated large budget deficits and became financially unsustainable, leading to partial state withdrawal from food crop and input marketing and associated stagnation or decline in the use of cash inputs on food crops (Jayne and Jones 1997).

Renewed growth in African agriculture will require financially sustainable intensification of existing crop-land, since most of the high-potential farmland in Africa is already under production. High-valued cash crops represent one potential avenue of crop intensification. Evidence from other parts of Africa shows that processes of agricultural intensification and productivity growth are often driven by cash crops with reliable markets and predictable returns (von Braun and Kennedy 1994; Kelly et al, 1995). But in addition to the direct effect of cash cropping on household incomes, there may be important indirect effects of cash cropping on the productivity of other household activities such as food cropping. These potential synergies or trade-off between cash crops and food crops have been generally neglected in food crop research and extension programs, although they may have important implications for programs designed to promote smallholder food crop productivity growth.[1] More comprehensive information on the interactions between food and cash crop production may help in refining extension strategies and in refining our understanding of the broader effects of cash cropping and associated commercialization of agriculture.

This paper studies the dynamics between cash cropping and food crop productivity at the household level. The paper focuses on the potential pathways by which cash crop production may affect food crop productivity and then empirically measures these effects using the case of Gokwe North District in Zimbabwe, a major cotton producing area. Results are based on econometric analysis of cross-sectional household survey data collected in 1996. The findings indicate that, especially under conditions of credit and input rental market failures, cash cropping schemes may enable households to increase both input use and productivity of other enterprises in their crop mix. A better understanding of why and how these synergies occur can help in the design of integrated commodity-input-credit partnerships between private firms and farmer groups.

[1] For informative exceptions, see Goetz 1993 and Dione 1989.

2. CONCEPTUAL FRAMEWORK

Agricultural commercialization may be defined as the proportion of agricultural production that is marketed. As such, commercialization can be measured along a continuum from zero (total subsistence-oriented production) to unity (100% of production is sold). Commercialization of agriculture involves a transition from subsistence-oriented to increasingly market-oriented patterns of production and input use. Economists have long advocated cash crop production as part of a broader strategy of comparative advantage. The underlying premise is that markets allow households to increase their incomes by producing that which provides the highest returns to land and labor, and then use the cash to buy household consumption items, rather than be constrained to produce all the various goods that the household needs to consume (Timmer 1997; Pingali 1997). While this concept of comparative advantage is well accepted under the assumption of well-functioning markets, the process of commercialization involving non-food cash crops is impeded by risks and high costs in the food marketing system. Food market failures give rise to the well-understood non-separability of household production and consumption decisions, which account for the potential breakdown of agricultural commercialization strategies based on comparative advantage.

The involvement of marketing firms in cash cropping schemes may be measured along a *risk-support* continuum. On one end of the continuum are firms that attempt to develop profitable opportunities with smallholder farmers while limiting their exposure to risks. These firms encourage delivery of smallholder products to the extent possible without extending major initial outlays in service support or credit that may not be recovered. While risks are minimized, this approach generally results in a lower volume of trade and hence has less potential to catalyze farm productivity growth. On the other side of the continuum are firms that pro-actively support input intensification of smallholder production in order to generate greater surpluses and throughput. This is often important for the firm in the presence of scale economies in processing (e.g., cotton ginning, sugarcane processing) and where fixed costs can be spread out over a greater volume of products handled. The most common approaches to pro-actively generate greater supply from farmers involve the distribution of credit, inputs, management and extension training, and seasonal labor support to participating farmers who have generally passed some screening requirements. These up-front costs are recouped in principle by the firm at the time that farmers sell their product. In some cases, marketing firms explicitly try to also promote food crop productivity even if they do not purchase these crops (e.g., in the case of Lonhro in Northern Mozambique, and the sugarcane outgrower schemes in parts of Western Kenya). The firms' rationale for supporting food crops is based on the belief that their cash crop operations will be more sustainable and profitable over the long run if their participating farmers are more productive in their food crop enterprises.[2] While this model has produced some noteworthy

[2] For example, if households are able to increase their food production per unit of land, they may devote a greater portion of their landholding to the cash crop sought by the firm.

successes from the standpoint of supporting smallholder income growth[3], the sustain-ability of such schemes depends on the firm's success in recovering its up-front outlays in support of farm production. Cost recovery is a function of (a) screening, how selective the firm is in registering farmers in the schemes that have a high probability of repayment (issues of adverse selection and the moral hazard come into play here); (b) market structure (e.g., number of competing buying firms in the market); (c) extent of coordination between competing marketing firms (e.g., sharing of information of which farmers are extended credit by which firms); (d) attitudes and responses by farmers concerning repayment. Platt's (1973) treatment of "social traps" is relevant here (e.g., individuals choosing actions that may be in their short-term interests but not in their long-term interests; or choosing actions that may be in their own interests but will bring down the system if enough other people take similar actions). These issues underscore that little can be said, either empirically or conceptually, about the performance of cash cropping schemes in promoting farmer welfare -- the institutional details of how the system is designed can make the key difference in performance outcomes. The task for researchers is to identify design elements in cash crop schemes that promote desired behavior to achieve mutual win-win outcomes for farmers, marketing firms, and others in the agricultural system, including consumers.

A key common feature of these sustainable cash cropping schemes has been "interlinked transactions," or the tying of credit (cash or in-kind) to the delivery of product at harvest. Provided that institutional arrangements are successfully designed to limit the incentives for farmers to "side-market" their output to other buyers, marketing firms may find it possible to profitably extend credit, inputs, and other services to support food crop production as well as cash crop production, and recover the credit and associated costs upon the farmer's delivery of the crop. By contrast, it may be hypothesized that in situations whether the institutional arrangements between the farmer and buyer are not successful in limiting incentives for diversionary sales of the cash crop, the pathway between participation in the cash crop scheme and food crop productivity may break down.

The key features determining the ability to limit diversionary sales are both institutional and crop-specific and food crops suffer from some key structural differences in this regard. Crops that are storable on the farm for long periods pose greater difficulties and costs for firms to ensure delivery than perishable crops. Market structure (e.g., the number of potential buyers operating in the market) also influences the ability of marketing firms to ensure recovery of loans and service support, but these problems can be mitigated by cooperation and coordination between buyers (e.g., sharing lists of farmers receiving loans from each firm, and agreeing not to buy products from farmers who have received loans from other marketing firms). However, when the number of potential buyers becomes very large, as it does with staple commodities (as many households themselves are in the market to purchase these crops), the potential for coordination among buyers breaks down, and credit recovery for up-front support services becomes extremely problematic. This may partially explain why staple food crops have seldom

[3] A few examples of these are the sugarcane schemes in Western Kenya (documented by von Braun and Kennedy 1994) and the Lonhro cotton schemes in Northern Mozambique (documented by Strasberg 1997).

been featured in commercialization programs involving private marketing firms operating at the support end of the *risk/support continuum*. While some crops are sold for cash, there is typically weak support from private marketing actors to actively promote the productivity of these crops through credit, input, management advice, forward markets for sale of output, etc. These observations underscore that certain types of commodity/market structure attributes appear more likely than others to attract private investment of the type pro-actively designed to promote smallholder crop productivity and in some cases the productivity of other farm activities.

2.1 Synergies Between Cash Crop and Food Crop Production

The case for cash cropping has generally been based on the direct contribution that *these crops* can have on farm incomes. A relatively neglected avenue of research concerns the effects that cash cropping can have on the productivity of other household activities. The following sections examine two potential pathways by which cash cropping may affect the productivity of other crops: (1) *household-level synergies*; and (2) and *regional spillover effects*.

2.1.1 Household Level Synergies

Household level synergies occur when the household's participation in a commercialized crop scheme enables it to acquire resources not otherwise available for use on other enterprises in the crop mix. There are several pathways of this type. First, under conditions of constrained access to farm credit, households' ability to intensify food crop production may depend on their participation in cash crop schemes. Credit market failures are commonly cited as a feature of rural agricultural economies (Binswanger and McIntire 1987; Adams 1988; von Braun, Malik and Zeller 1993; Platteau 1991; Bolnick 1992; Goetz 1993; Mosley 1994; Poulton, Dorward and Kydd 1998). Credit market failures may create non-separabilities between input used in food production and participation in commercialization programs. Strasberg (1997), for example, found that under credit and input market failures in Northern Mozambique, participation in cotton outgrower schemes was the primary means of acquiring cash inputs for use on food production. In parts of Western Kenya, smallholders engaged in sugarcane outgrower schemes to obtain access to credit, input, extension services, and equipment for use not only on sugarcane but also on food crops. The sugar company's explicit support of out-growers' food crop production was based on the premise that this would raise smallholders' ability to be sustainable and profitably participate in the sugarcane scheme, which would in turn provide longer term benefits to the company (Nyoro and Jayne, forthcoming). In Zimbabwe, high non-repayment rates led to the demise of the state-led program for disbursing in-kind credit for food crop production (Chimedza 1994). In its wake, private cotton marketing firms began administering, in some areas, a credit line for inputs and equipment for cotton producers perceived as having low risk of credit default. The equipment package includes ploughs, which also can be used in maize production. While the inputs are obtained through a cotton-based credit line, farmers' use of the equipment is spread out to food crops in order to improve profitability. Without cotton production, these farmers would not have access to the credit that assists in capitalizing the farm. These examples underscore the potential non-separability between production technologies used

in food crop production and the decision to grow selected cash crops and participate in associated marketing schemes.

Investments by marketing firms to promote cash crop production may also raise the productivity of existing household resources devoted to food crop productivity. Private sector marketing firms have contributed to farmer training where commercial crops are involved. In Zimbabwe, the Department of Agricultural and Technical Services (AGRITEX) cooperates with private fertilizer and pesticide manufacturing firms in training farmers at the Cotton Training Institute (Mariga 1994). One important part of the training program focuses on pest scouting. Farmers get extensive training in determining the critical stages of economic injury to a cotton stand. Mariga (1994) argues that cotton instills discipline in farmers because of its stringent husbandry requirements. Such knowledge does not only improve cotton management skills but improves the overall quality of farm husbandry. For example, farmers with knowledge on cotton pest scouting are also able to determine the stage at which a maize stalk-borer or grain weevil causes economic injury. It is clear that investment in human capital emerging from cotton training programs has a positive spillover effect on food crop productivity.

Thirdly, the promotion of high-value, high-return enterprises may improve households' ability to invest in lumpy assets such as animal traction. In Mali, 70% of the farmers surveyed by Dione (1989) perceived cotton production and usage of fertilizer as the two most important conditions determining the profitability of animal traction adoption. According to Barrett et al. (1982) market conditions for cash crops affect farmers' capacity and decision to invest in draft animals and equipment. Reliable market outlets provided by some cash crop schemes have provided returns that secure a steady payoff to the investment. By contrast, the commonly witnessed volatility of domestic staple food markets makes investment in animal traction and fertilizer risky unless these inputs are also targeted for use on other crops that raise the expected returns and stability of returns of the overall farm activity.[4]

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2.1.2 Regional Spillover Effects

[4] In some areas, food crops may be cash crops and play a dynamic role in agricultural commercialization.

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Regional spillover effects occur when a commercialization scheme may attract certain kinds of investment to a region which also provides spillover benefits to other activities. For example, the increased availability of key inputs (for purchase on cash basis) may result from the promotion of input-intensive cash crop schemes. Dione (1989) found that the introduction of cotton to Southern Mali increased the demand for fertilizer, which subsequently stimulated private investment from input manufacturers, distributors, and retailers, who decentralized their services into major producing areas. These investments made fertilizer and other inputs more accessible and profitable not only for use on cotton (which was the primary impetus for private investment in the provision of inputs in these areas) but also for farmers who only produced grain and other staple crops (Dione 1989). These examples highlight the potential synergies between input-intensive cash crops and subsistence crops.

Regional spillover effects can also occur when agricultural commercialization spurs private investment in market infrastructure and human capital that improves productivity of other farm activities, including food crop production. It has been observed that private investment in transportation infrastructures to support cash crop activities has also raised the returns to smallholder grain production and grain traders' operations (Strasberg 1997). In some cases, "cess" collected from cash crop revenue has been used to make community improvements in schools and education, roads, sanitation, etc.

2.2 Summary of Key Pathways

The general inductive argument built up from these cases is that commercialized crop production and marketing programs may create important synergies with more subsistence-oriented crops. These potential synergies arise from both household and regional spillover effects. In some cases, through interlinked transactions for inputs, credit, management, and sale of products, the institutional mechanisms between farmers and marketing firms can relieve some of the market failure problems that constrain input intensification on grain crops.

But whether these synergies actually arise depends on the type of perspective and approach that firms may adopt toward smallholders. We have defined these investment approaches along a *risk/support continuum.* One approach is to limit exposure to risks, and hence just passively accept surplus products offered by farmers, and perhaps offer inputs on cash basis. The key limitation of this approach from the standpoint of the firm is that in the presence of scale economies in processing or distribution (as with cotton, sugarcane, coffee, etc.), firms may face difficulties with this approach in lowering costs enough within the set of feasible procurement and sale prices to operate profitably. Relatively fewer synergies between cash crops and other household enterprises are anticipated to occur through this approach. At the other end of the continuum is the strategy of pro-actively encouraging smallholder surpluses through disbursement of credit, inputs, management advice, etc., in order to generate higher levels of production, and attempting to recover these costs at harvest through purchase of crops from the farmer. The potential advantages of garnering greater throughput and lower per unit marketing costs must be considered against the potential risks of not recovering up-front costs of services to

farmers if side marketing becomes an issue. Farmer responses to the potential for opportunistic behavior also determines the long run sustainability of this approach.

We have hypothesized four pathways by which crop commercialization based on high-value, high-return crops may promote food crop productivity:

1. Under credit and input market failures, commercialization schemes may improve farmers' access to credits and inputs through participation in the cash crop scheme. The success and sustainability of this pathway may depend on the firm's ability to recover its credit and associated costs of supporting smallholder production.

2. Input-intensive cash crops, by promoting market demand for inputs, may induce private sector investment that improves the availability (and reduces per unit costs) of key inputs that can be used on a wide range of crops.

3. The promotion of high-value, high-return enterprises may improve households' ability to invest in lumpy assets such as animal traction.

4. Commercialization may support private investment in infrastructure and human capital that has broader benefits for other economic activities such as food crop production.

3. DATA AND SAMPLING FRAME

Evidence used in this study is based on a multiple visit survey of 480 rural households in 1996. The survey was designed and implemented under the Project on Integrated Assessment of Trypanosomosis Control Strategies and their Impacts. This component of the overall project was through collaboration between International Livestock Research Institute, University of Zimbabwe, Regional Tsetse and Trypanosomosis Control Program, and the Department of Veterinary Services Tsetse Control Branch of Zimbabwe.

Only one district, Gokwe North, was selected for implementing the survey. Gokwe is a major cotton producing area and has been a destination for internal immigrants seeking the fortunes associated with cotton. The area is relatively newly settled and farm size is larger than the national average. The influx of immigrants into Gokwe is often dubbed as "the white gold rush". A four-stage stratified sampling procedure was adopted to select study sites within Gokwe North. The first stage involved the purposive selection of three cluster areas that experienced early, mid and recent tsetse fly clearance. The agro-ecology across the sites was uniform, each falling into Natural Region III. The three sites were found along the major drainage systems with land comprised of flood plains and terraces of the larger river systems. Soils were moderately well drained, moderately shallow, sandy clay loam or clay. The soils had high agricultural potential and no farmers in the sample applied any supplementary nutrients. The most limiting input was animal traction because the soils (vertisols) were hard and difficult to work manually.

During the second stage, two wards were purposively selected from each of the cluster areas. Selection of two wards gave the study an opportunity to identify any differences in local administration that could have affected the settlement process. For the third stage, two villages were purposively selected within each ward: one village had the best access to services in 1996 and the other village had the worst access to services at that time. At the fourth stage, a random sample of 40 households, representing approximately 15-25% of the village population was drawn from each village. The resulting sample size was 482 households. Households were interviewed about their demographics, size and potential of land, cropping patterns, management practices and their asset holding.

4. RESEARCH QUESTIONS AND METHOD OF ANALYSIS

The conceptual framework in Section 2 argues that the intensity of cash crop production may influence the productivity of other crops in a farmer's activities. This section develops a model for measuring (1) the determinants of commercialized crop production at the household level, and (2) the effect of increasing crop commercialization on household food crop productivity.

Some key descriptive features of the data were important in guiding model specification. Cropping patterns in Gokwe North are concentrated on two crops. Maize accounts for 47.4% of cropped area, while cotton accounted for 45.2%[6]. However, there are clear differences in the purposes for growing these crops: 100% of the cotton production was marketed, while 93.8% of maize production was grown for home consumption. Cotton sales contributed 83.6% of the value of marketed crop income. In this area of Zimbabwe, agricultural commercialization is virtually synonymous with expanding cotton cultivation.

None of the sampled farmers in the survey used formal credit to acquire cattle. Livestock credit programs have poor loan recovery rates and have inherent insurance problems. Agricultural credit market failures and a lack of formal cattle credit and rental markets have made cash crop production one of the few remaining pathways by which farmers can accumulate the capital required to purchase draft animals and traction equipment. If and where markets for seasonal inputs, equipment, livestock credit, and livestock rental are available and can be tapped to support food crop production, the pathway between cash cropping and intensification of food crop production is hypothesized to be de-emphasized. On the other hand, where agricultural credit and input markets for food crops are constrained, as in Gokwe North, we hypothesize that the cumulative formation of household input and capital base and success in cash crop production may generate positive spillover effects on food crop production. In the presence of such market failures, households may be unable to acquire credit and service support from the private sector for use on food crops except through participation in cotton schemes.[7]

Given our hypothesis that a household's grain crop productivity may be related to its involvement in cotton production, we developed an indicator of cotton commercialization to measure this relationship. We define the index of household cotton commercialization as the value of cotton sales over total crop production for household *i*. This index is neutral with respect to farm production, and measures the household's involvement in cotton relative to its total farm output. This index ranged from zero (for 14% of the cases) up to 96% across the sampled households, with the mean value being 42%. Since only 14% of the sampled households did not plant cotton in 1995/96, OLS estimation was used to identify factors affecting cotton commercialization. We then used a two-stage least square estimation to

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[6] The remaining 8% of cropped area was devoted to groundnuts, sunflower, millet, and sorghum.

[7] As mentioned earlier, the current situation contrasts markedly to the period of state-led food production campaigns during the 1980s, where the state was actively involved in the disbursement of credit and inputs for use on food crops, and in purchasing food crops from farmers.

determine the effects of cotton commercialization on food crop productivity. To the extent that the areas under cotton and food crop productivity are decisions made within the same growing season, it is necessary to use an instrumental variables approach. As such, a conditional productivity function and a crop-mix function were developed. The two equations below represent the theoretical framework of the determinants of commercialization and their effects on food productivity.

The household cotton commercialization index function is

(1) $C_i = d_0 + d_1 X_i + d_2 A_i + e_i$ (i = 1,.., 453 households);

and the conditional productivity function is:

(2) $Y_i = b_0 + b_1 X_i + b_2 C_i + v_i$

where Y_i is the gross value of food output per hectare of food crops[8]; X_i is a vector of exogenous household and location variables; C_i is the cotton commercialization index, an endogenous variable; A_i is a vector of instrumental variables used to predict C_i; and e_i and v_i are residual terms. Definitions of the specific exogenous, endogenous and instrumental variables and their expected signs are found in Table 1.

What is the hypothesized pathway by which food crop productivity in (2) is related to the intensity of household cotton production? The presence of *household-level spillover effects* is measured by the effect on the endogenous variable *Ci* on grain crop productivity in (2). *Regional spillover effects* are proxied by a village-level variable in (2) specifying the number of private retail dealers involved in distributing cotton inputs. This variable is designed to measure the extent of investment in cotton-related service provision. We hypothesize that as the density of cotton-related services increases, there will be positive spillover benefits for the intensification of other crops grown in that area.

The choice of instrumental variables in (2) was driven by the hypothesis that these variables are strongly correlated with cotton commercialization and uncorrelated with food crop productivity. Three variables were chosen as instruments: the number of knapsack pesticide sprayers owned, distance to nearest cotton buying outlet, and categorical variable specify the gender of the household head. Pest management is a critical factor in the success of cotton production in the region. The availability of knapsack sprayers was considered important in determining farmers' area allocation to cotton. The distance to the nearest cotton marketing outlet determines the level

[8] This is admittedly a partial measure of land productivity, but data was not available to construct more sophisticated measures of multi-factor productivity due to the paucity of information on land rental values and seasonal labor wages.

Table 1. Description of Variables Included in Models

	Anticipated Sign	
	cotton commercialization index (C_i)	Food crop productivity (Y_i)
Exogenous Variables (X_I)		
Adult equivalents (No)	+	?
Land holding (ha)	+	-
Household head years in school (yrs)	?	?
Value of farm capital (Z$)	+	+
Number of animal draft teams	+	+
Interaction of farm capital with number of draft teams	?	?
Concentration of master farmers	+	+
Locations with recent tsetse control =1; otherwise =0	?	?
Locations with mid tsetse control = 1; otherwise = 0	?	?
Locations with early tsetse control = 1 otherwise 0	?	?
Number of private traders in village	-	+
Endogenous variables (C_i)		
Cotton commercialization index (%)		+
Instrumental variables (A_I)		
Number of knapsack sprayers owned	+	IV
Distance to cotton marketing depot (km)	-	IV
Gender (1 if female 0 if male)	-	IV

of transaction costs farmers incur when marketing the surplus or purchasing inputs. In Kenya, Omano (1998) observed the effect of transport costs on cotton production to be enormous. Finally, due to the labor-intensive nature of cotton production, we expected female-headed households to participate less in cotton production given more severe time pressures than other households with at least two adults. Also, cotton has traditionally been viewed as an activity engaged in by males; while this is slowly breaking down in some areas, cotton remains an activity engaged in primarily by men. Evidence from other countries presented by von Braun (1994) also indicate that female managers are less involved in cash crop production but play a more significant role in food crop production. We expected the gender effect to be insignificant in food crop productivity. The Pearson correlation coefficients between the dependent variable in (2) and number of knapsack sprayers, distance to cotton market outlet, and the gender variable were -0.03, 0.05, and -0.06, respectively, none of which were statistically significant at even the 20% level.

5. CHARACTERISTICS OF COMMERCIALIZED SMALLHOLDER FARMERS

In the presence of constrained input delivery and credit programs for food crop production, households may be unable to acquire credit and service support from the private sector for use on food crops except through participation in cotton schemes. Indeed, farm capital investment appears positively related to cotton commercialization (Table 2). Farmers not growing cotton had less than half the draft-equipment and oxen assets as the rest of the sample. As a result, non-cotton growers were largely dependent on poorly functioning rental markets for animal traction,[9] and only 42% of these farmers were able to use animal traction at all in 1995/1996. By contrast, 76% of cotton growing households used animal traction. Cotton production in this area of Zimbabwe is clearly correlated with animal traction and draft equipment ownership. To acquire draft cattle in Gokwe North District, 53% of the farmers used income from cotton, 20% used a combination of cotton and maize income and 18% used wage savings (Govereh 1999).

The bivariate statistics in Table 2 indicate that the relationship between cash and food crop production is neither entirely competitive nor complementary. Households that devoted greater proportions of land to cotton tended to achieve lower grain yields than non-cotton growing households. The amount of grain available per capita from own production was substantially lower among the cotton-intensive households than the non-cotton growers. These findings seemingly support the position of many critics of non-food cash crop production, i.e., cash crops take land and labor resources away from cereal production. However, if we consider that per capita cereal consumption requirements are approximately 20kg of cereal equivalence per month, many of the households in the top quartile of cotton area produced on average more grain than their household's consumption requirements. About 45% of the households in the top two cotton commercialization terciles produced all their grain requirements. By contrast, 59% of the non-cotton growers were grain self-sufficient. The findings suggest that, at least in this particular area, even the most intensive cotton producers did not neglect food crop production and many produced enough for family needs. While this may not be a generalizable finding, arguments against cash crops on the basis of food market failures may be negated to the extent that highly commercialized households tend to secure at least some portion of their food needs through own production.

Another key issue is whether smaller farms commercialize disproportionately less than those with large farms. The data in Table 2 indicates that household cotton commercialization was indeed positively related to land holding size. These results suggest a sequential hierarchy of crop choice: households cultivating less area (generally lacking animal traction and labor to expand cultivation of the highly clayey soils in this region) tend to put priority on food production. Non-cotton producers tended to have relatively large parts of their farm under fallow. Households with sufficient draft power to expand cropped area, while not neglecting food crop cultivation, are better able to exploit the higher returns of cotton production. As discussed earlier, highly commercialized cotton farmers had more draft power and equipment to cultivate a greater

[9] None of the sampled farmers in the survey used formal credit to acquire cattle.

proportion of total land area. These results support empirical findings elsewhere that small farms tend to have food-dominated cropping systems (Omano 1998).

Table 2. Household Characteristics according to Cotton Commercialization Index in Gokwe North District, Zimbabwe, 1995/1996

Characteristics	---------- Cotton commercialization index [a] ----------				
	Non-Cotton Growers (0)	1st Tercile (1% - 66%)	2nd Tercile (67% - 82%)	3rd Tercile (>82%)	Total
Sample	75	122	126	107	430
Grain Yield (kg/hectare)	1165	1443	1037	1007	1167
Grain Output (kg/capita)	481	495	331	263	385
Total crop income (Z$/total hectares cropped)	1690	2271	2340	3001	2396
Total crop income (Z$/capita)	639	1492	1525	2822	1732
Grain self-sufficient (%)	59	81	50	41	57
Grain selling households (%)	20	42	25	21	27
Household cotton sales ($)	0	3633	5409	10597	5387
Land size (ha)	4.39	5.62	5.66	7.87	6.04
Fallow area (ha)	1.29	.78	.71	.78	.85
Family size (No.)	5.9	6.4	6.8	6.6	6.5
Farm capital investment (Z$)[b]	2254	4353	5120	6806	4855
Animal draft teams (number)	.36	1.09	1.20	1.65	1.14
Used animal draft power (%)	42	74	75	79	70
Family head years in school	4.5	5.9	6.0	6.8	5.9
Master Farmer Certified (%)	2	6	12	11	8.4
Female headed (%)	21.0	11	11	11	13.0
Distance to market (km)	27.5	25.2	23.5	22.6	24.5
Tsetse controlled early (%)	41	27	35	29	33
Mid tsetse controlled (%)	13	27	35	56	34
Tsetse controlled recently (%)	46	46	30	15	33

notes: [a] cotton commercialization defined as value of cotton sales divided by value of total crop production. [b] Farm capital investment includes value of draft equipment, pesticide equipment, etc.
Source: Socioeconomic Impact Assessment of Tsetse and Trypanosomosis Control Surveys, Gokwe North District, Zimbabwe, 1996/97.

The association between cotton commercialization and area under fallow suggests that access to land was not a limiting factor in commercialization. Households not growing cotton had almost 70% more land under fallow on average than the cotton-growers, despite having smaller landholdings (Table 2). These findings indicate that other factors, such as ownership of animal traction and other farm assets may be more critical in influencing households' ability to expand cropped area and thereby exploit cotton production.

About 21% of the non-cotton households were headed by female-managers compared with only 11% among the cotton growers. The most cotton intensive farmers had also invested two more years in school than non-cotton growers. In addition, about 10% of the cotton producers were certified "master farmers" compared with 2.6% among non-cotton growers. Cotton production requires immense managerial discipline from growers and the quality of decision making and information processing is critical.

Data in Table 2 also indicate that household cotton commercialization is related to the length of time that has elapsed since the eradication of tsetse fly-borne disease. As mentioned earlier, use of animal traction is important for expanding cotton production, and the viability of draft animals is related to the clearing of tsetse disease. Locations that were recently cleared of tsetse disease exhibited a generally lower intensity of cotton production. About 45% of the non-cotton growers were located in areas recently cleared of tsetse disease, compared to only 15% of households in the highest cotton commercialization tercile.

Household cotton commercialization was associated with higher gross per capita crop income. Households in the top cotton tercile had about double the crop income per hectare and five times the crop income per capita as the non-cotton producers. This observation is consistent with evidence found in other studies of agricultural commercialization (von Braun and Kennedy 1994; Strasberg 1997; Jayne 1994). Specialization in high value cotton enabled farmers to boost their incomes. We now examine the hypothesis that cotton commercialization improves food crop productivity.

6. ECONOMETRIC RESULTS

Table 3 presents results for both the commercialization and food crop productivity models.

6.1 Determinants of Commercialization

Demographic, household, and regional factors were important determinants of household-level cotton commercialization. Prior investment in animal traction teams had a significantly positive influence on the commercialization index (p=.037). This corroborates farmers' perceptions that the use of animal traction is necessary for timely planting and for providing the right soil tilth that is critical for germination and root development on these clayey soils. Other factors constant, an additional team of oxen was associated with a 2.7% increase in the cotton commercialization index (evaluated at the mean level of draft equipment, and accounting for the influence of the interaction term between draft equipment and draft teams). The value of draft equipment also had a positive and significant association with cotton commercialization. A 50% increase in draft equipment, other factors constant, raised cotton commercialization by 1.4% (at the mean level of draft teams owned).

Ownership of a pesticide knapsack sprayer was also positively associated with cotton commercialization. Farmers could conceivably borrow sprayers, but ownership allows for more control over the timing of spraying, which affects the yield. Ownership of an additional knapsack sprayer was associated with an 8.4% increase in the cotton commercialization index, *ceteris paribus*. The effect of distance to market also had the expected sign and was significant at the 0.01 level. Everything else being constant, cotton commercialization declined by 12% for every additional 10 kilometers distance between the farm and the nearest buyer. Controlling for the effects of other factors, the gender variable was also found to be important. This may reflect the increased burden on the women's time in female-headed households. Also, while this relationship appears to be breaking down over time, cash crop production in Zimbabwe has traditionally been regarded as under the domain of adult males. These variables, which were used as instruments for cotton commercialization in equation (2), were each significant at the 5% level in equation (1), and as mentioned earlier, were only weakly correlated with the dependent variable in model (2). These results indicate that these three variables are reasonably good instruments for use in model (2).

Although the direction of the impact of farm size on household cotton commercialization was as expected, the relationship was not significant. The insignificant effect of farm size is expected given evidence elsewhere that farm size does not limit participation in commercialization (von Braun 1994). Family size had a positive but insignificant impact on commercialization. Use of hired labor, data on which was unavailable, might account for the apparent weak association between these variables.

Table 3. Econometric Models of Commercialization and Food Crop Productivity, Gokwe North District, Zimbabwe, 1995/96

	Equation (1) Dep. Var.: commercialization index (%) (OLS)		Equation (2) Dep Var: Value of grain production per hectare (IV)			
			(a)		(b)	
Endogenous Variables	Coeff	T-stat	Coeff	T-stat	Coeff	T-stat
Commercialization index (value of cotton sales /total crop output)	--	--	1013.8	1.984*	1122.57	2.157*
Exogenous variables						
Farm size (ha)	6.103E-03	1.717**	-53.039	-4.568*	-57.00	-4.726*
Family size (equiv.)	2.036E-03	0.501	3.491	.261	4.524	.333
Family head school years	1.299E-02	3.169*	.893	.064	-.3274	-.023
Draft equipment ($)	6.182E-06	1.365	.0227	1.533	.0233	1.555
No. of draft teams	3.719E-02	2.100*	86.194	1.342	71.52	1.089
Draft teams * Draft equipment	-3.06E-06	-1.998*	-0050	-.953	-.0045	-.857
Early cleared gradient	.131	3.724*	-150.27	-1.163	-162.79	-1.242
Mid cleared gradient	.127	3.403*	-1027.7	-6.718*	-1088	-6.816*
Master Farmer certificate	6.880E-02	1.366	58.262	.329	79.67	.442
No. of cotton input dealers	--	--	--	--	19.926	1.421
Instrumental variables						
No. of knapsack sprayers	8.484E-02	3.711*	--	--	--	--
Dist to market (km)	-1.19E-02	-4.631*	--	--	--	--
Gender (1=female)	-8.38E-02	-2.062*	--	--	--	--
Constant	.556	7.120*	1207	6.183*	1090	5.133*
S.E.	.2778	.2781	908		920	
N	428	428	428		428	
Adj. R-square	.268	.266	.1790		.1768	

*(**) denotes statistical significance (one tailed test) at the 5% (10%) level. Source: Socioeconomic Impact Assessment of Tsetse and Trypanosomosis Control Surveys, Gokwe North District, Zimbabwe, 1996/1997.

The econometric results also suggest that the number of years the family head spent in school was directly related to household cotton commercialization (p=.002). Cotton production demands high quality management. While education level was an important predictor of cotton intensification, training in general farm operations and management had a positive but less significant effect. Much of the extension training for Master Farmers has traditionally been biased towards maize production and against cash crops.

Lastly, results from (1) show that locations that were cleared of tsetse flies relatively early, thus allowing for more thorough integration of livestock with cropping operations, consequently had positive effects on household cotton commercialization. Farmers in locations more recently cleared of tsetse were still adapting to their new environments.[10]

6.2 Effects of Commercialization on Food Productivity

Two different estimations were run on equation (2): one without the regional spillover term (2a) and one with (2b). Calculations are based on 2b, but results for 2a are provided for the reader's perusal.

Results in Table 3 highlight the complementary relationship between cotton commercialization and food crop productivity at the household level. Each additional percentage increase in the commercialization index was associated with a Z$11.23 per hectare increase in the value of grain crop production per hectare. This relationship is significant at the 0.05% level. To put this result in perspective, the findings indicate that the expected value of food grain output per hectare of food crops for households with a cotton commercialization index of 57% (i.e., the mean level for all households in the sample) would be 38.1% greater than households not growing cotton. These results corroborate similar findings from Kenya and Mozambique highlighting the potential synergies between food crops and cash crops (Strasberg et al. 1999; Strasberg 1997; Dione 1989; Goetz 1993).

Farm size had a significant and negative effect on food crop productivity. Other factors held constant, smaller farms were more productive in the use of land than large farms. The results suggest that food crop productivity declines by Z$57 per hectare (4.5% of mean productivity levels in the sample) as landholdings increase by one hectare, *ceteris paribus*. This finding is also consistent with findings from Mozambique and Kenya cited above.

Investment in animal traction teams and farm capital had a positive but insignificant effect on food crop productivity. The effect of animal traction teams and equipment investment on maize productivity is indirect as the major and direct effect is on commercial production. This finding supports other results from Mali and Ghana (Dione 1989 and Panin 1989). Investments in animal

[10] Note that the location categorical variables are not designed to capture differences in agro-ecological potential as this factor was controlled for in the selection of sample sites, as explained in Section 3.

traction have been found elsewhere to boost returns to labor, although this issue was not investigated in this paper.

The inclusion of the regional spillover variable (the number of input suppliers in a village) had only a marginal contribution to the adjusted R^2 of (2). While the effect on food crop productivity was positive, it was significant only at p=0.16. Everything else constant, an additional cotton input retailer in the area boosted grain output by $20/hectare. These retailers not only provided inputs and services relevant for cotton production, but also tended to sell maize inputs especially hybrid seed. Informal interviews with retailers and farmer groups indicated that traders were attracted into those villages that concentrate on cotton production by the potential demand for household and farm inputs. Demographic attributes such as family size, education level, and extension training did not have important impact on food crop productivity. The spillover effect from cotton production had the expected direction of influence but the impact was insignificant.

The effect of tsetse disease eradication on the predicted value of food crop production per hectare was significantly different in the middle cleared period. Households located in areas cleared during the early and late periods had significantly higher levels of grain productivity. The reasons for this finding are not clear and indicate that there are other omitted location factors being picked up by these variables.

The adjusted R-square, while low at 0.176, is not unusual for cross-sectional household data. Other omitted factors that are likely to influence the dependent variable include hours of household, hired and animal labor, field losses, soil nutrient levels and plot planting dates. Interactions among those variables included in the model might help explain additional variation in grain productivity.

7. CONCLUSIONS AND IMPLICATIONS

Research results are beginning to shed light on constructive and meaningful ways by which the private sector can configure its operations in the post-market liberalization environment to promote smallholders agricultural productivity. Findings from other parts of Africa have shown that there are a wide variety of arrangements through which private marketing and processing firms have related to smallholders, each differing in their level of investment and support of smallholder production (Dione 1989; Jaffee 1992; Jaffee and Morton 1995; Strasberg 1997; Strasberg et al. 1999). The findings indicate that there are major differences in performance (i.e., intensity of input use, crop productivity, and smallholder incomes) across different types of cash cropping arrangements involving private firms and smallholders. The more successful cash cropping arrangements between smallholders and private firms have a markedly positive effect on food crop productivity and smallholder incomes. This emerging empirical work is beginning to indicate strongly that commercialization of smallholder agriculture, featuring high-valued cash crops, can under certain conditions provide a strong stimulus to smallholder agriculture and have major indirect benefits for food crop productivity.

In Zimbabwe, the government has in the past decade gradually privatized its services and allowed free entry of private firms into most segments of cotton marketing. Government withdrew its involvement in disbursing seasonal loans but paved the way for private-sector credit schemes for those farmers with potential to reimburse the credit. Agricultural chemical and fertilizer companies are opening up distribution outlets in major cotton producing areas. The resultant competition in domestic cotton marketing increased seed cotton prices and improved the quality of services to farmers including speedy payment for deliveries. The impact of government withdrawal is benefitting smallholder cotton producers and this represents an additional pathway to sustain growth in the cotton industry.

Most local and internationally-based agricultural research programs designed to promote food crop productivity growth in Africa are based on the allocation of scarce resources to primary food crops. To a large extent, agricultural and nutrition policies in Zimbabwe have historically formulated rural development strategies on this conventional wisdom and have implicitly or sometimes explicitly regarded diversification into non-food cash crops as detrimental to household food security objectives. While productivity growth of staple food crops is indeed essential to overall rural productivity growth due to the large proportion of cropped area under food crops, the potential of higher-valued cash crops to promote food crop productivity has often been neglected.

This paper investigated the effects of agricultural commercialization on food crop productivity in Gokwe North District in Zimbabwe, a major cotton producing area. The principle findings of this investigation include:

1. Cotton commercialization at the household level significantly and positively affected food crop productivity, *ceteris paribus*. The expected value of food grain output for households at the mean level of cotton commercialization was 38.1% higher per hectare of food crops than

households growing no cotton. Also gross crop income per hectare and per family member were positively related to the share of cotton in cropped cultivation.

2. Traction equipment and draft power were found to be key determinants of households' ability to diversify into cotton production. Under the relatively land-abundant conditions of the study area, animal traction allows households to put more land under cultivation, and therefore is a major source of increased farm production per capita.

3. Commercialization was significantly positively affected by farm size, other factors held constant, but farm size was significantly inversely related to food crop productivity.

4. The level of education, maturity of the household head and the household's investment in animal traction significantly and positively affected food crop productivity.

5. The degree of agricultural commercialization varied significantly across locations at various stages of settlement development. The development stages for the settlements were driven by the relative timing of tsetse control.

Overall, the findings show that farm dynamics between cash cropping, capital investment, and food crop output, are important to consider in discussions of agricultural commercialization among smallholder farmers. Two key pathways have been identified by which crop commercialization may improve food crop productivity. First, in constrained credit markets and unattractive domestic grain prices, crop commercialization and non-farm activities become the main avenues by which smallholders can overcome the capital constraints on making investments in key productivity-enhancing inputs and capital. Second, once these investments and commercialized cropping patterns become initiated and incorporated into the households' farm activity, this appears to support a dynamic process of human and physical capital accumulation and further intensification of input use, thereby enabling further gains in food crop productivity.

The challenge for government policy is to identify and facilitate strategic pathways to create positive interactions between food and cash crops, and between the public and private sector. The various pathways by which crop commercialization can affect food security and incomes, under conditions of a pervasive market failure, needs to be more clearly understood to develop more informed policies in support of smallholder welfare. This study suggests that, despite frequent criticisms stressing the trade-offs between agricultural commercialization and food crop production, it is important to also consider the potential synergies.

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