THE WISDOM OF TRADITION IN THE DEVELOPMENT OF DRY-LAND FARMING: BOTSWANA

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Introduction

Scholars, planners, and policy-makers concerned with the "economic development" of poor countries have come increasingly to attend to problems of small-scale farming and its potential contribution to the commonweal. Foremost among the reasons for this are the following: (1) increases in aggregate production taking place on large commercial farms are frequently offset by declining production associated with small farms; (2) growth of large farms has often resulted in, or been made possible by, displacement of small farmers, who become landless rural laborers or unemployed city dwellers; (3) growing disparities in income and welfare between the commercial sector (including agriculture) and small farming can be in many countries most practicably slowed down by raising small farm incomes; (4) small farming is increasingly seen to be a ready source of new job creation at a time when the stagnating industrial/commercial sector is falling further and further behind burgeoning demands for wage labor; (5) most poor countries are pointlessly spending scarce, hard currency to buy food staples, which they could readily grow themselves on small farms.

Interest in development of traditional farms has been accompanied by concern to understand their economies. Seminal works such as those of Wharton[1] and Schultz[2] laid much intellectual groundwork for the economic and anthropological study of small-holder agriculture and for the launching of practical efforts to develop it. In the decade and a half

since publication of these works, several dozen major textbooks and readers have echoed, and added credence to, Schultz' and Wharton's ideas.

Stevens[3] has given a cogent summary of the consensus that Schultz and Wharton have inspired. The central features of small-scale, traditional farms are said to be: (a) they operate in an economic equilibrium: (b) technology is constant; (c) farmers' preferences for holding given sources of income is constant; (d) marginal preferences for acquiring and using given factors is in equilibrium with their real marginal productivity; (e) traditional farmers have achieved optimum allocative efficiency in the use of factors of production (i.e., no decrease in the use of any factors(s) can be made without decreasing output, and no increase in output can be made without increasing at least one factor of production); (f) all known available technology is being used; (g) traditional farming has very "low productivity."

Given this description of the small, traditional farm, the recipe for "developing" it follows with almost deductive necessity. As Stevens avers: "[this model] has pruned away false views of small farms in low income nations, making possible clear focus upon the two major sources of increased productivity in farming: <u>technological change</u> and <u>institutional innovation</u> . . ."[4] (emphasis mine). On this view, technology changes are expected to move the production function upward--i.e., all factors will produce more when certain technological innovations are made. Institutional innovation is seen as that which will (a) provide incentives to greater production, (b) reliably supply needed inputs, (c) remove barriers to accumulation of capital and investment of surpluses.

The "false views" that this new consensus has pruned away seem at base to be nineteenth-century notions that peasants are mired in the idiocy of rural life, and are irrational, if not lazy and stupid. While the new view is better than the old, serious problems remain with the new one, especially the now tacit, now explicit supposition that Western commercial agriculture is the goal (or very much like the goal) to which small-farm development should be directed. Jejune excitement with agribusiness inspired notions like "bigger yields" leads to curious perceptions of small farms and conceptions of what farm productivity might usefully consist in.

While we are quite fastidious in our definition of productivity in discussions of Western firms, the concept becomes quite simple-minded in most discussions of small farmers' production in the Third World. Often it is taken to be nothing more than average tonnage of crop harvested per hectare of land or per person-day of labor. Little or no attention is paid to the cultural organization of agriculture in the total context of social reproduction. This uni-dimensional view of productivity becomes scandalously invidious when comparisons are made between production in traditional regimes and those in modern ones. Obtaining "bigger yields" becomes the goal, and the justification for claiming the necessity of "technology transfer" and "institutional innovation." Corollary to this is the assumption that the cultural organization of traditional farming constitutes not a resource in expanding production, but is rather itself an obstacle to development.

Recent history testifies clearly that the "bigger yields" which technology and institutional change claim to provide are frequently not

forthcoming, or are only of marginal scale. (Peasants or their culture are often blamed for this failure.) Where bigger yields through mechanization are effected, they often displace small- and middle-size farmers and become associated with rural plantation systems, which hire at wretched wages a small number of the displaced peasantry. These developments are of course well known in connection with the Green Revolution, as it has been put into effect in Southeast Asia, India, and Mexico.[5] Attention paid exclusively to aggregate yields blinds us often to the staggering social costs of institutional dislocation generally accompanying technology transfers and institutional innovation and the real economic costs often not paid for by the few farmers adopting and profiting from new technologies.

In this paper I wish to present one illustrative case study which highlights several misconceptions in the highly touted current view of traditional farming and the recipes for making them more "productive." The case is important because its lessons apply widely throughout dryland areas of the world where cereals are the staple food crops. I will try to demonstrate the risks and costs of technology transfers, even where effort has been made to make them locally "appropriate," and will show that great potential for increased production exists within the culture of traditional agriculture as it is currently practiced.

Botswana: Background

Botswana, a large, Texas-sized territory of 650,000 square kilometers, and an independent nation since 1966, is located in south-central Africa. Its population is about one million. Botswana's total arable

land area is about three million hectare. Currently about 80,000 rural households attempt arable and/or livestock production on some scale on a land area where about 400,000 to 600,000 hectare are at any given time under fairly regular cultivation. Rainfall over the eastern third of the country and the far north varies from an average of about 400 to 600 mm. per annum. The western two-thirds of the country is very dry desert. Annual variations in rainfall within a given region are considerable. Long spells (of about ten years) with rainfall continuously above or below the long-term mean by 10 percent or more each year is a common pattern in most regions. The rainy season is, in name, from November through March, but the annual total can fall within one or any combination of those summer months. Vagaries of rainfall freight agriculture with great risk and uncertainty.

The population is growing rapidly, at greater than 3 percent per year. The absence of rural job creation, coupled with a 50 percent decline in South Africa's recruitment of mine labor in Botswana over the past five years, has led to a horrific growth of urban populations. All of Botswana's major towns are growing by at least 13 percent per year, most of this from the in-migration of people who cannot achieve subsistence-level production in farming and who require some, very modest, cash income.

Of the measured GDP, agriculture, including beef production accounts for 25 percent. Mining, commerce, and government account for the rest. Income distribution is highly skewed in favor of those in commercial production, including farming and government employment. The bottom 50 percent of households in the ranked distribution earn 17

percent of GDP traceable to income, while the top 10 percent of households earn 42 percent of income. Among rural households, the bottom third in income rank realize less than $120 in cash income per year.[6]

The three principal sources of food energy produced in Botswana are sorghum, maize, and millet. Aggregate annual production of these has varied in the last fifteen years from 8,000 to 118,000 tonnes. Minimum requirements are currently for about 200,000 tonnes.[7] The shortfall is made up by imports, all coming through, most originating in, South Africa. Yields per hectare are among the lowest in the world, with cereals averaging about 250 kilograms per hectare over the past ten years. In 1980 the returns to land for the three major cereal crops were: sorghum, 215 kg. per hectare; maize 167; and millet 159.[8] The land area cultivated in a given year varies among homesteads as does timely access to draft power, cattle. Fifty percent of the 80,000 households engaged generally in farming cultivated fewer than 3 hectare of land; 18 percent did not cultivate at all. Only 10 percent of farmers in 1980 cultivated more than 7 hectare. Given the average household composition of seven or eight members, and the average production of sorghum (by far the most popular crop) of 215 kg. per hectare, a household would have to cultivate over 8 hectare of land to raise a subsistence cereals crop. Fewer than 8 percent of farmers did this in 1980.

Control of, or rights of access to, cattle is clearly associated with capacity for extensive cultivation. Those families not having demand-rights of access to oxen (but having to "borrow" or hire them when they are available) planted on average in 1980 1.7 hectare; those

with between 1 and 10 cattle planted on average 2.6 hectare; those with between 11 and 40 cattle planted 3.8 hectare. Larger herd sizes are not systematically associated with more extensive cultivation. According to most government surveys 28 percent of farming households had no demand-rights to cattle, 17 percent had demand-rights to between 1 and 10 cattle, and 16.5 percent had demand-rights to between 11 and 20.[9]

What data are available suggest strongly that the differences in aggregate household production are traceable to the extensiveness, not the intensiveness or efficiency of cultivation. So, for example, the following data for 1980:[10]

Cattle Herd Size	Average Area Cultivated	Yield per Hectare
0	1.7	106 kgs
1-10	2.6	102
11-20	3.8	130
21-30	3.9	148
31-40	3.7	141
41-50	4.5	215
51-60	4.0	133

The slight increase in yield associated with greater herd size and larger area of cultivation is probably to be accounted for by the fact that a disproportionate number of the larger cultivators with large herds are found in the generally more well-watered regions of Botswana--e.g., the far south of the country--and have command over greater quantities of labor for weeding and bird-scaring.

An intensive study of a select group of "progressive" farmers--i.e., wealthier larger farmers who had entered into favorable clientage

relations with the extension service of the Ministry of Agriculture--had in 1975-1976 (a year with very felicitous rainfall) average yields of sorghum of 341 kgs, only 29 kgs above the reported national mean for that year and 481 kgs of maize, 200 kgs above the national mean for that year.[11] (This latter difference is probably due to use of fertilizer by many of the progressive farmers. We return to this point below.)

An analysis of the gross marginal return to land realized by these "progressive" farmers showed that on average the net "profit" from growing cereal crops was about $14.00 per year per hectare. The statutory minimum wage in Botswana at that time was about $1.20 per day! Clearly growing cereals as a cash crop hardly pays. The welfare value of the crop far exceeds its market producer price.

Government Plans and Policies

In its fourth national development plan, the cabinet announced its goals for Botswana's agriculture: (1) attainment of self-sufficiency in the production of food staples; (2) raising rural (cash) incomes through production of surpluses for marketing; (3) creation of rural employment opportunities in rural agriculture (in addition to the self-employment resulting from attainment of the previous two goals); and (4) saving foreign exchange by production in substitution of imports.[12]

For all the last five years Botswana has imported (by weight) more cereals than she has produced. And almost all of the other foodstuffs have been imported. The cost and volume of these imports have been rising.

The government has attempted to implement its goals by establishing

a national plan for the development of agriculture, called the Arable Lands Development Policy (ALDEP). While there are many dimensions and features of this plan, its cornerstone is to be a "package" of factors and associated delivery services which are to be provided to small farmers in order to markedly upgrade the productivity of their arable farming. Experimental research in Botswana and an "Integrated Farming Pilot Project" have been carried out since 1975, most of the support coming from the United Kingdom.

The Integrated Farming Pilot Project at Pelotshetlha

Pelotshetlha is a farming area in southeastern Botswana, about 35 kilometers from the local regional capital of Kanye and comprising about 23,000 hectare of arable land and about 325 farming households.[13] The farmers of this area are by and large more prosperous than most in Botswana. Only 35 of the families lack demand-rights to cattle. In most years, most of these farmers plow between 6 and 10 hectare of land. Soils are either shallow medium-to-coarse grained (loamy) sands or heavier, clay and sand soils, both types overlying a layer of calcrete. Soils are poor in nutrients, particularly phosphorus and nitrogen.

There is no significant land scarcity. An arable rotation with a grass phase is traditionally followed. Timing varies highly from area to area, household to household. The single-blade mouldboard plow is drawn by in-spanned oxen (4 to 12 beasts). This technology has been adopted over the past one hundred fifty or so years. The most widely grown crops are sorghum, maize, millet, beans, and cowpeas. Sorghum and maize account for over 90 percent of total cultivation.

In 1974-1975 the Ministry of Agriculture, with technical and financial support of the United Kingdom Overseas Development Ministry, set out to establish at Pelotshetlha a model "Integrated Farming Pilot Project" (IFPP hereafter).[14] The basic plan, developed in India, is one which seeks to introduce to traditional farmers a whole package of arable practices and technology, rather than piece-meal to introduce innovations one at a time. The package approach is supposed to be implemented in a real-life situation, on the fields of practicing farmers, who will be able to see for themselves the differences in the inputs and the outcomes associated with their traditional methods and the modern integrated package respectively. In this project every effort was said to be made to make sure that the package was practicable for smaller as well as more prosperous farmers.

Initially 55 farmers were induced to join the scheme. The entitlement was the farmers' agreement to plant at least two hectare of land using the package's recommended inputs and practices. In return, farmers would receive subsidized fertilizers, free initial use of a multi-purpose ox-drawn tool bar ("locally adapted") and lots of advice and supervision.

In 1976-1977 financial and economic analysis of the scheme's effects, and differences between scheme cultivation and traditional cultivation were reported.[15] In 1978 when I arrived in Botswana to work as a rural development consultant to the Institute of Development Management, it was widely reported that despite the cautious, but certainly positive 1977 report, scheme farmers were disenchanted with the pilot project. Not only were no new farmers being recruited, but previous committed

farmers were dropping out of the scheme.

My investigation consisted in an analysis of financial and economic data contained in the IFPP report for 1977, supplemented with an on-site field study of scheme and non-scheme farmers' operations. Crop yields, labor time requirements, and returns to land and to labor were recorded for the IFPP package and for the traditional system.

The IFPP Package

The package of arable practices recommended to traditional farmers include the following:[16]

(a) Winter (dry-season) plowing or sweeping to kill weeds and reduce compaction of soil, thereby reducing water loss through evaporation and transpiration

(b) Regular crop rotation, but omission of a grass phase in the cycle. (Grass does not add much humus, because of termite activity and the high temperature of the soil.)

(c) Use of precision tools in plowing, planting, weeding, ox-drawn or tractor-drawn

(d) Application of fertilizers (250 kgs superphosphate per hectare for sorghum and 250 kgs 2-3-0 per hectare for maize)

(e) Use of improved seeds

(f) Two weedings after planting

(g) Planting after first rains in November

(h) Harvesting immediately at maturity to reduce loss from birds and insects

This regime differs from the traditional scheme in many ways, the most immediately significant being that in the traditional system there is:

(a) Plowing only after the first summer rain, with planting immediately thereafter

(b) One weeding, if any at all

(c) The single-blade plow is the only tool used; seeds are broadcast

(d) Harvesting depends, as does plowing, on labor availability

(e) No fertilizer is used, except manure intermittently and irregularly

Both systems require "bird-scaring" in the case of sorghum. In their report of 1977, the IFPP recorded the following data on yields of sorghum and maize:[17]

IFPP Package for maize:	825 kgs/hectare
Traditional system for maize:	358 kgs/hectare
IFPP Package for sorghum:	522 kgs/hectare
Traditional system for sorghum:	142 kgs/hectare

It must be noted that the yield for sorghum recorded for the traditional system is anomalously low. 1976-1977 had had fairly abundant rains. In these conditions, under the traditional system, the yield of sorghum typically is quite close to that for maize. In dry years the yield for sorghum is much higher than that for maize. If farmers had harvested their IFPP-grown sorghum first, early frost might have killed the traditionally-grown sorghum. If bird scaring on the traditional fields had been less diligent than that on the IFPP fields, loss due to birds could be an explanation. The "bird-scaring" speculation receives some support from the labor studies. The IFPP economic report indicates that the mean number of hours spent per hectare on bird-scaring under the traditional system was 28.18 hours, while that done under the Package system was 150.58 hours.[18] We will augment these data with more representative data in the analysis that follows.

A comparison of the traditional system with the IFPP system reveals two things immediately. The IFPP system requires much more labor, a

much greater capital investment, and much higher use of inputs which are only available for cash, including hired extra labor, than does the traditional system.

To facilitate this comparison, I make a few assumptions, corresponding quite close to reported material. Farmers are cultivating close to 10 hectare of land, about half sorghum and half maize. We ignore for now the small-scale cultivation of legumes. In years of good rain, this mix of the two crops is disadvantageous in that the maize yields better. In dry years, sorghum yields better. The half-half strategy would appear like a balance between maximizing yield and maximizing security.

Each hectare of cultivated land can be said to consist in one-half hectare of sorghum and one-half hectare of maize. We compute returns to land, using imputed market prices, as this is the basis for the supposed appeal of the IFPP scheme, and the basis for showing its putative superiority over the traditional system.

Costs	IFPP[19]	Traditional
Capital Investment (in Pula; 1 Pula = $1.20) ("makgonatsotlhe," the all-purpose tool bar)	750 (minimum)	250 (maximum) (based on personal surveys)
Labor Time (in person-hours)		
per 1/2 hectare sorghum	135	43.5
per 1/2 hectare maize	64	39.0
Fertilizer		
per 1/2 hectare sorghum	8.75	None
per 1/2 hectare maize	17.00	None

Capital depreciation: 10 percent per annum straight line, divided by

number of hectares:

IFPP	7.50 per hectare per annum
Traditional	2.50 per hectare per annum

Labor cost: generously assume proportion of hired labor same for both IFPP and Traditional systems (1/4 of labor hired at P1.00 per day = 12 to 13 thebe [cents] per person-hour):

IFPP (135 + 64)/4 x .12 =	5.97 per hectare
Traditional (43.5 + 39)/4 x .12 =	2.48 per hectare

IFPP per hectare costs:

Capital depreciation	7.50
Hired labor	5.97
Fertilizer	25.75
	39.22 per hectare

Traditional per hectare costs:

Capital depreciation	2.50
Hired labor	2.48
Fertilizer	.00
	4.98 per hectare

Returns (average yields per hectare) x sale price BAMB[20] (producer price) in 1976-1977:

IFPP
- Sorghum: 522 (1/2) = 261 kgs per half hectare
- Maize: 825 (1/2) = 412 kgs per half hectare

Traditional (based on personal surveys of scheme and non-scheme farmers in area):
- Sorghum: 284 (1/2) = 142 kgs per half hectare
- Maize: 273 (1/2) = 137 kgs per half hectare

Sale prices vary markedly (BAMB prices are about one-half to one-third of retail shop prices in large villages and in towns). BAMB price per 70-kg bag of sorghum, 1977, 5.67; maize per 70-kg bag, 5.15.[21]

Revenue per hectare:

IFPP: 261/70 x 5.67 + 412/70 x 5.15 =
21.14 + 30.31 = 51.45 per hectare

Traditional: 142/70 x 5.67 + 137/70 x 5.15 =
11.50 + 10.07 = 21.57 per hectare

Gross Margins (total revenue less total costs):

IFPP: 51.45 - 39.22 = 12.23 per hectare
Traditional: 21.57 - 4.98 = 16.59 per hectare

The monetary returns to labor in terms of value of product per person-hour is quite obviously far more unfavorable to the IFPP system than are the returns to land, with the IFPP labor requirement more than double that of the traditional system.

What this analysis suggests is this: using production figures for the traditional system which represent typical crop yields and by using cost figures for equipment, labor, and fertilizer that are current and which in fact are likely to rise faster than the producer or retail price of cereals, we see that the traditional system gives a more favorable return than the IFPP system.

However, there are two additional questions which must be considered. One, what is the effect on the returns to these two systems given substantial increases in market prices per bag? Second, what is the effect of input subsidies on returns?

Many farmers choose not to sell to BAMB, selling at point of harvest instead, and thereby obtaining better prices. Likewise, a rise in BAMB producer prices changes the results of our analysis. Thus, if sorghum (70-kg bag) is sold for P13.00 and maize (70-kg bag) for P12.00, the gross margin for Traditional farmers would be:

(142/70 x 13) + (137/70 x 12) = 26.37 + 23.48 = 49.85 - 4.98 =

44.87 net revenue per hectare.

For IFPP farmers the analogous figure would be:

(261/70 x 13) + (412/70 x 12) = 48.47 + 70.62 = 119.09 - 39.22 =

79.87 per hectare.

Raising producer prices tips the balance in favor of the system with the greater yields. But raising producer prices by government fiat creates a host of its own problems and simply transfers the government outlay from food imports to price subsidies.

The marginally greater absolute yields associated with the IFPP system might suggest that its potential is not being realized, during initial trials. In fact there is evidence that the traditional system is capable of significant improvement, without the use of scale-dependent capital inputs like the relatively very expensive ox-drawn tool bar, which costs most than five times the annual per-household cash income of the poorest 25 percent of Botswana's farmers. (This point is illustrated below.)

The 1977 IFPP report suggests that the increase in labor requirement associated with the modern system can be met with family labor available.[22] This is a dubious premise. Labor is scarce in Botswana because the household sends its members away, in part to school and in part to wage labor elsewhere in Botswana and in South Africa. Labor requirements, like draft power requirements, are not simple quantities; they are time-dependent. Having the labor or draft power available at just the right time is the key to successful dry-land farming. As is shown below, changes in the timing of certain steps in cultivation can often

by themselves improve yields with no other inputs required. For the labor input increase in one step of the arable cycle to "pay off," there must exist commensurate labor for all of the other steps in the cycle. Thus, if extra labor is available to clear larger fields, there must exist extra labor for plowing, weeding, and harvesting them. This is true of technical inputs like fertilizer. One of the biggest complaints made to me by both scheme and non-scheme farmers was that fertilizer makes weeds grow much faster and more healthy than it makes crops grow. So if there is a shortage of labor for weeding, the net effect is a field choked with weeds.

The modern system was said by farmers I interviewed to require the hiring of labor to make the other (than subsidized inputs) pay off. In Botswana the hiring of labor is very problematic because labor can earn a much better wage in town, even with the high unemployment there, than it can working in the rural areas. Second, labor is often not available for hire when it is most needed, because the potential hirelings are working their own fields at the same time as their labor might be sought by an employer.

The capital input costs and the operating costs (principally fertilizer) make the start-up of commercial farming feasible only for the richest traditional farmers. The risks of loss due to drought are so high that the potential losses associated with a halving of the total yield are much greater for the modern system. The "break-even" yield is about 350 kgs per hectare for the modern system and about 75 kgs per hectare for the traditional system. In the 1976-1977 survey of scheme farmers, two farmers in seven had yields below this break-even point,

while none of the traditional farmers did.

Of course this financial approach is misleading. It doesn't reflect how traditional farmers think. But it does reflect how Western experts think. And if the modern scheme is defective in terms of the way we Westerners ourselves think, why are we recommending that the Tswana adopt it en masse?

The standard rationalization for the failure of technology transferred is to assume that the conditions of knowledge and skill of the "beneficiaries" is itself not sufficiently developed to make use of the new technology. The technology is supposedly the result of "science," so nothing should be wrong with it. In fact a study in Botswana carried out by an agronomist sensitive to and familiar with the traditional system has shown that the traditional system has the capacity for increased productivity with minor alterations in the technical inputs. The minimization of scale-dependent inputs increases the attractiveness of such "modified traditional" approaches to smaller farmers, with little cash, and makes it far more congenial to those for whom increased risk is intolerable. In dry-land farming, risk aversion is a key element of the survival strategy. While a large-scale and episodic production of large surpluses may help the rich farmer avoid the calamity associated with a given year's crop failure, this avenue is not open to the small farmer. Further, unless the farmer can adopt a whole package of inputs, he may be better off slightly modifying his traditional system, which he knows the requirements of, how it works and is guaranteed rights of access to irrespective of previous harvest failures.

The Appropriateness of Tradition: Seed Broadcasting

For small farmers in particular, adoption of new mechanical equipment is generally impracticable, because its "profitability" depends upon extensive use of it. Most hardware is scale-dependent. One must plow many hectare of land to make economically feasible even a seemingly modest capital investment. In most of the third world a piece of equipment costing $500 is beyond the credit line available to farmers, beyond the value of their production to pay for, and beyond the security of their production to cover the risks of acquiring.

In Botswana, as in the rest of the world, conventional Western wisdom has it that mechanization increases yields. And so it does. However, the variation in or uncertainty of its effects from farm to farm and season to season (however large its yields) suggest that its adoption is too risky for all but the largest cultivators.

This generalization is particularly apt in the case of draft power: animal versus motorized traction, and planting: broadcast versus mechanized row planting. In Botswana very few farmers use motorized traction (a disaster in Africa). But many more are considering, or are being encouraged to use, mechanical planters instead of broadcasting seed.

In his examination of data obtained in the IFPP project at Pelotshetlha for the year 1979-1980, Lightfoot[23] found that while mean yields for sorghum among farmers using two different types of mechanized row plowing and planting were 198 and 369 kgs per hectare respectively, he also discovered the following: among 45 traditional farmers (or hectare using the traditional system), 6 achieved yields above the mean for either of the improved mechanized systems and 8 achieved yields above

the mean for the less successful of the two improved systems. Further, these 8 traditional farmers attained yields equal to or better than those achieved by 18 of the farmers using the improved systems. Naturally, this overlap becomes more startling when one computes the real costs of operating one of the improved systems and considers the losses incurred when yields fall below a "break-even" return.

Examining data for the four-year period 1977-1980, gathered on farms participating with the Agricultural Research Department in a farming systems study, Lightfoot found that among those farmers with highest yields per hectare the mechanized, improved system outperformed the traditional system by a factor of only between two and four (depending on the year) and that the best yields in fields planted by the traditional system exceeded the average of yields for the improved system in two out of the four years.[24] The degree of increase over traditional broadcasting associated with mechanized planting depends importantly on the quantity and quality of the rainfall. Drought conditions tend to make yields for the improved and traditional systems converge. Lightfoot further observes that with mechanical planting, unless one has sufficient labor to carry out periodic weeding, the full advantage of row planting is greatly diminished.[25] Unless one has the resources, including labor, to carry out a whole set of practices, the adoption of a single mechanized contrivance may be counter-productive. This may explain some of the failure of the improved systems to dramatically outperform the traditional systems.

In a final set of observations Lightfoot reports the results of experimental trials conducted by the Agricultural Research Department with

broadcast planting alone, varying the timing of planting (planting on dry seed bed versus wet) and the mode of plowing (shallow tillage versus deep tillage and shallow tillage together). The latter two sources of variance can be traced to management practices and the use of plows with different length blades. No fertilizers were used during these trials, and presumably other maintenance of the crop, such as weeding, was constant.

The yields associated with hand-broadcast seeds in these experimental trials were 1,310 kgs per hectare average, with row-planted seeds 1,298 kgs per hectare. No significant difference. The difference in yields with hand-broadcasting associated with timely plowing after the ground is wet and deep tillage of soil, as opposed to hand-sowing on a dry bed after shallow tillage was dramatic: a mean yield of 2,537 kgs per hectare for the former and 250 kgs per hectare for the latter.[26]

Over all conditions the mean yields for hand-broadcast seeds were 1,310 kgs per hectare.[27] These were achieved without fertilizer, but did occur on soil with nutrients more plentiful than is typical for Botswana.

While very wealthy large-scale farmers could do even better with full mechanization and regular fertilizer application, this is irrelevant for over 95 percent of Botswana's farmers, who are planting on 1-7 hectare of land. So why recommend, as a primary means of improvement, increased mechanization or "transfer of technology," which can be adopted only by a few? Among even those few, many will not be able to use machinery to full agronomic or economic potential.

Lightfoot's observations and experimental trials suggest that vast

improvement in yields can be obtained by changes not in the forces of production, but in the quality, timing, and patterning of various tasks associated with management of the arable cycle. Improved management will require no more competent labor power than is required by transfer of exotic technologies. The labor constraint still exists. But the labor required does not generally represent the application of qualitatively new skills. Nor does improved management rest on so many foreign ideas or knowledge, as is the case in the use of machinery, the application of herbicides, or the introduction of plantation regimes. Furthermore, there exist in place in Botswana and in many other dry-land farming areas indigenous schemes for pooling labor and sharing in the use of the forces of production. These share-cropping techniques, very efficacious in the indigenous system for pooling effort and diffusing risk, gain a new and lease on life in labor-intensive approaches to agricultural development.

The big problem in campaigning for agricultural development through alteration of manage ment is enticing family or lineage members back to the farm, and, for a time at least, out of the desperate search for wage labor. One must be able to hold out a credible prospect of subsistence or a modest money-earning capability in farming to make such a return to the homestead worth trying. Evidence suggests strongly that the marginal or total return to labor from improved farming systems need not equal the "opportunity cost" of labor as measured by expected urban wages in order to bring many or most of the uneducated rural people back to farming.[28] Few of Botswana's small farmers desire or seek to maximize wage income, or even maximize the return to labor per year.

Farming is part of a cherished culture still. Further, the returns possible from subsistence farming are higher per labor day than they are in most available wage employment. A family can grow the welfare value of subsistence with fewer labor days' work than the same welfare value can be obtained by earning wages and buying back family subsistence from the shops. Wage labor for many in Botswana is part of family security. If the security can be obtained through reliable harvests, much of the impetus to wage-labor migration can be obviated.

Conclusion

The goal of farm-household food self-sufficiency for Botswana would be achieved if all of Botswana's current 80,000 farm families each could cultivate 3 hectare of land and harvest 600 kgs of cereal per hectare. The entire country could be fed if the area cultivated by each farm household were to average 6 hectare or if yields could reliably be increased above 600 kgs per hectare or some combination of both. All of the resources for this "scenario" already exist and are in place. Adequate, fair distribution of these factors--arable land, animal draft power, labor for each of the aspects of the arable cycle (coupled with good crop management practices)--are sufficient to provide in many if not most years a subsistence crop of food staples for the entire country, and gainful employment for many thousands of Botswana's people, who now live off their wits in search of work in Botswana's growing towns.

The argument made here in the case of staple cereals applies *pari passu* to cash crops like oil seeds, fruit, green vegetables, and the like. Concern for aggregate increases in production often obscure the

equally important issue of distribution of the means and rewards of production. This paper suggests a way in which to realize the aggregate goal of food production, the provision of rewarding livelihoods for individuals and families, and the greatest security of all against the rapine of the wage relationship, control of the means of subsistence production.

Footnotes

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4. Ibid., p. 11.

5. Pearse, Andrew, Seeds of Plenty, Seeds of Want: Social and Economic Implications of the Green Revolution (Oxford: Clarendon Press, 1980).

6. Oland, Kristian; Hoyt Alverson, and Ralph J. Cummings, Jr., Targets for Agricultural Development in Botswana (New York: International Agricultural Development Service, 1980), p. 10.

7. Ibid., pp. 14 and 24.

8. Litschauer, John G., and William F. Kelley, The Structure of Traditional Agriculture in Botswana (Gaborone, Botswana: Ministry of Agriculture, 1981), p. 19.

9. Ibid., p. 24.

10. Ibid., pp. 26 and 31; data calculated by author from raw data as cited.

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12. Oland, Alverson, and Cummings, op. cit., p. 19.

13. [N.A.], "Objectives and the IFPP-Farm Management Survey at Pelotshetlha," Gaborone Ministry of Agriculture (n.d.), pp. 1-2.

14. Ibid.

15. [N.A.], "Economic Aspects of Farming Systems Used at IFPP," Gaborone Ministry of Agriculture (1977).

16. [N.A.], "Objectives and the IFPP-Farm Management Survey at Pelotshetlha," op. cit., pp. 4-5.

17. [N.A.], "Economic Aspects of Farming Systems Used at IFPP," op. cit., p. 2.

18. Ibid., p. 3.

19. Ibid., pp. 2-4; calculated by author.

20. BAMB is the Botswana Agricultural Marketing Board.

21. Figures obtained by personal communication with BAMB officials.

22. [N.A.]., "Objectives and the IFPP-Farm Management Survey at Pelotshetlha," op. cit., p. 7.

23. Lightfoot, C. W. F., "Broadcast Planting in Perspective," Gaborone Ministry of Agriculture (1981).

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25. Ibid.

26. Ibid., p. 11.

27. Ibid.

28. Hoyt Alverson, Mind in the Heart of Darkness (New Haven: Yale University Press, 1978), Chapter 6.