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Exploring farmers' practices and the factors influencing them during production seasons in Ghana and Zimbabwe through the use of participatory budgets

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Abstract
This paper describes the findings of research that aimed to 1) understand the constraints faced by farmers during production seasons and 2) evaluate the usefulness of a novel participatory method for exploring farming practices and resource use with farmers. Detailed research was conducted with 22 small scale tomato producers in Tano district in Ghana and six small scale farmers in Buhera district in Zimbabwe. Working individually with each farmer, participatory budgets were constructed in advance of the coming production season to indicate farmers' planned activities, resource use and production. During the season each farmer was visited every month and actual activities, resource use and production recorded and compared with the plans. Reasons for differences were explored and at the end of the season a revised participatory budget drawn up. The process identified a range of seasonal social, natural and economic factors, both expected and unanticipated, which effected farmers' practices and livelihoods. Funerals, sickness and community labour commitments reduced labour availability and delayed planned activities. Early onset of rains In Ghana reduced the spraying period and higher than expected temperatures led to the additional activity of having to shade plants. Actual inputs varied from those planned due to unavailability and to farmers responding to the condition of the crop. A glut in production severely reduced tomato prices in Ghana and resulted in many farmers not harvesting large proportions of their crop. The use of participatory budgets in this research was time consuming but increased researchers' and farmers' understanding of seasonal factors and of potential solutions to these problems.

Introduction
Seasons dictate many farming and household activities but unpredictable changes in a variety of factors within seasons also have strong influences. Cooper et al (2008) indicated that farmers make decisions both before seasons and then during them as part of coping strategies to climate variability. Dorward et al (1997) noted that it is often only during the season that real conditions become clear regarding key factors e.g. labour availability, fertiliser availability, household needs, rainfall, crop and weed conditions and it is only then that farmers can make some key decisions regarding for example crop management. Richards (1989) likened farmer decision making during a season to a 'performance' and noted that farmers make sequential adjustments in response to unpredictable conditions as they unfold rather than making and sticking to plans created prior to the season.

Understanding the nature of changes that can occur within seasons, and how farmers and households respond to them, is important for variety of reasons including determining the

likely impacts of changes in conditions, identifying constraints faced by farmers and developing appropriate innovations.

Participatory budgeting was developed as a method which sought to facilitate improved farmer decision making both before and during seasons (Dorward et al 2003). It drew on concepts from both farm decision making tools and Participatory Learning and Action and aimed to meet several criteria, namely to: include and enable quantification of all resources important to the farmer in decision making (not just cash and profit); be simple and easy to use, particularly for non and semi-literate people, and; take account of changes over time i.e. during the season. Participatory budgets have been successfully used by and with farmers for a range of purposes including exploring the resource implications of making changes to an enterprise, analysing farmers' existing activities, resource use and production, comparing different enterprises, and planning new enterprises.

Several authors have called for studies of farming systems and farmers' constraints to be an on-going process (Ellis 1998, Gordon 1996, Mudhara 1996) and this has arisen from the identification of weaknesses with short term problem identification exercises. A major limitation is that of seasonal bias. Farmers' priority problems vary with the time of year and therefore when an exercise is undertaken can affect results (Erbaugh et al 1998). Similarly such exercises can fail to take account of the dynamic and sequential nature of farmer decision making already noted earlier in this article. Furthermore, one-off short-term exercises can fail to highlight the heterogeneity of farmers' situations within a single system by working with groups (Matsaert et al 1998). Working with individual case-study farmers could help to highlight the diversity of farmers' situations and avoid socioeconomic bias (if careful selection is undertaken) and can also lead to better relationships between facilitators/ researchers and farmers (Doorman 1990). Ongoing activities which involve repeat visits over a season or longer and work with individual case-study farmers offer a way of addressing these limitations. It was considered that participatory budgets could provide a useful method to do this.

The research described in this paper therefore aimed to 1) understand the constraints faced by farmers during production seasons and 2) evaluate the usefulness of participatory budgeting for exploring farming practices and resource use with farmers.

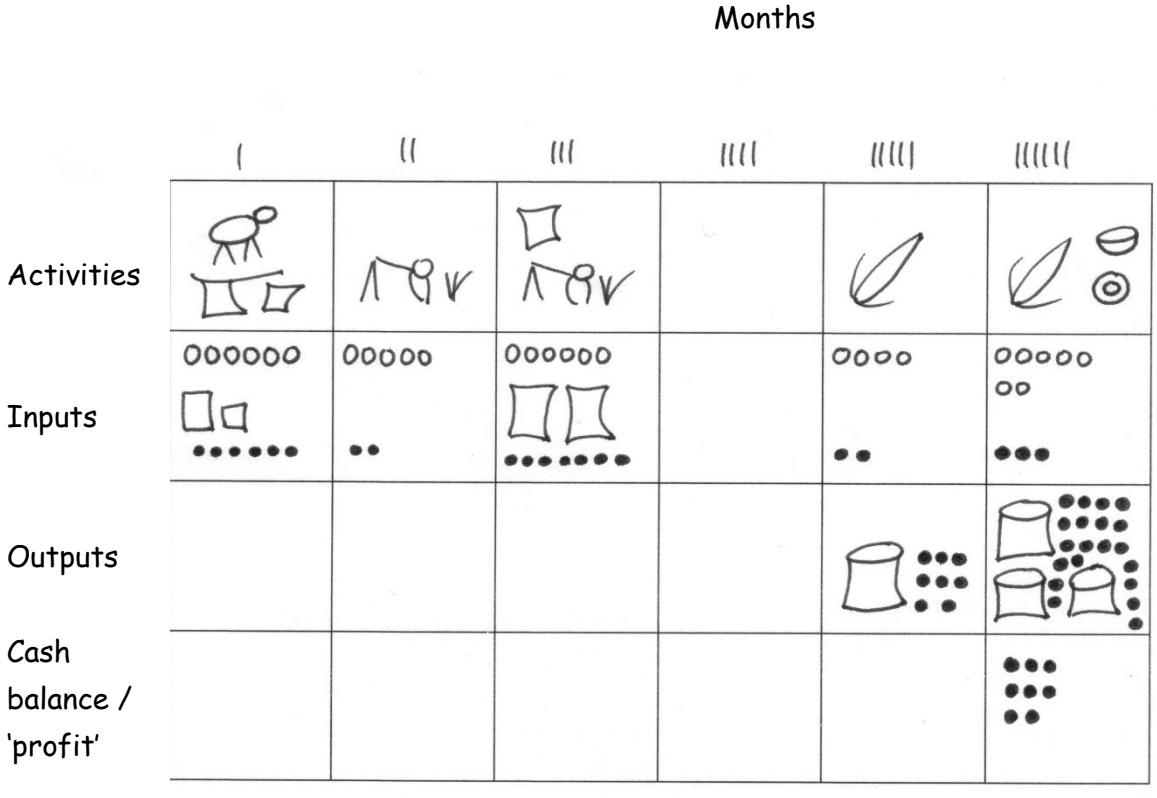
Approach

Two studies were conducted. The first and smaller study was with six households in Ward 12, Buhera district, Zimbabwe (two women and four men). Here the climate is semi-arid (Region four) with one distinct wet season per year and farmers grow mainly maize, with some sorghum, millet, pulses and vegetables. Building on the experience from Zimbabwe a second study was conducted with 22 dry season tomato producers in Dwomo village, Tano district in the Brong Ahafo region of Ghana. This is in the Forest zone which has a bimodal rainfall pattern. Here a wide variety of crops are grown and dry season tomato production is the main cash crop and often practised by young men because of its cash earning potential coupled with its high demand for labour. Very few women in the village are involved in dry season tomato production and therefore only two participated in the study. A wealth ranking

exercise was conducted in the villages in Zimbabwe and Ghana and used to ensure that final selections of farmers reflected the spectrum of wealth observed.

Participatory budgets are tools which examine a farmers' use and production of resources over time for a specific enterprise. On a board or grid, time is represented by each column being a month, week, day or other period of time. The first column is therefore the first month, the second the second month etc. In the top row(s) activities that occur in each time period are indicated using symbols. In subsequent rows the types of resources used are indicated by different symbols or counters and these are placed in the correct time period and below the relevant activities. Quantities of resources are indicated by the number of symbols / counters, with a value attached to each. Similarly, types and amounts of resources produced by the enterprise are represented in a row below. Figure 1 indicates the broad layout of a participatory budget although actual examples are more detailed than illustrated here.

Figure 1. Example layout of a participatory budget



Resource allocation maps were also used. These are maps (e.g. of a farm) which have marked on them the types and amounts of resources used an produced for a specific time period e.g. a month or a season (Galpin et al 2000).

Before the season individual farmers indicated their planned activities and resources for the coming season by constructing participatory budgets on the ground for their planned enterprise. Each farmer's participatory budget was then copied on to an A1 size piece of flip

chart paper to be kept by the farmer. The planned activities and resource use for the first month of the season were then summarised on to another A1 size sheet of flip chart paper as a resource allocation map, using symbols to indicate activities and resources. This A1 sheet was amended and annotated by the farmer during the month to indicate actual activities undertaken and resources used.

Figure 2. Diagram of research process

Timing	Activity
1) Prior to growing season ↓	1a) **PB plan** for each enterprise 1b) **RAM** (whole farm) **plan** for month 1 made up
2) End of month 1 ↓	2a) **RAM actual** for month 1 compared with planned RAM and reasons for differences identified and discussed 2b) **RAM plan** for month 2 made up
3) End of Month 2 ↓	3a) **RAM actual** for month 2 compared with planned RAM 3b) **RAM plan** for month 3 made up
(continue for 'n' months) ↓	(as in 3) above)
X) At end of growing season ('n'th month)	Xa) Compile **actual RAMs** into **actual PBs** and compare with original **planned PBs**. Discuss and explore differences.

PB: participatory budget RAM: resource allocation map

A researcher visited each farmer approximately every month and discussed changes from the plan and the reasons for those changes. A (revised) plan for the next month was then made up, in the light of what had actually taken place in the previous month. This procedure of planning, recording and re-visiting continued through the production and marketing period (see figure 2). At the end of the exercise the information on actual activities and resource use was combined on to an actual participatory budget. An example of an interpreted planned participatory budget is given in figure 3. At the end of the season farmers also met in groups to discuss the exercise and their findings from it. These discussions proved important in clarifying and confirming researchers' findings and observations. The extent to which the

season was different from others, to give an indication of the 'representativeness' of the season, was also discussed.

Results

Planned activities and resource use in ward 12, Buhera district, Zimbabwe

All farmers planned to grow maize as their main crop and therefore plans were made up for maize and one other crop. These were groundnuts (four farmers), sorghum (one farmer) and sunflower (one farmer). Planned planting dates for maize ranged from October to December and reflected the status of land preparations and the predicted arrival of the rains. Predicted yields ranged from 250 – 1,000 Kg per acre, and varied with farmers' levels of optimism and pessimism with regard to the rains. Regarding labour, most farmers planned to use immediate family members. One planned to draw on extended family members and another planned to hire labour. All farmers had access to draft power but this varied from shared access, with or without influence, to full individual ownership and control. In discussions on labour availability farmers indicated that this is influenced by school holidays and the resulting availability of children to work on the farm in addition to the availability of visiting relatives.

Actual resource use and outcomes in ward 12, Buhera district, Zimbabwe

On the whole, maize yields were very poor with only one farmer achieving his expected yield, despite farmers planting planned areas. The two farmers who planted in November achieved highest yields (720 Kg and 510 Kg per acre). Other farmers' yields were lower than 100 Kg. This was put down to the very poor rains. Rains were not only approximately six weeks late in arriving but also the quantity and distribution once they did arrive was very poor. Poor rains caused delayed land preparation and planting which was largely achieved in late November or December. Only one farmer who had planned to plant in December achieved his planned planting date. All farmers reported significant losses to termite damage, even to green maize. The poor rains exacerbated this. Sunflower and sorghum crops were also affected by poor and late rainfall with yields falling well below those hoped for.

Of the four farmers who planned to grow groundnuts, one farmer did not plant due to a delay caused by having to attend several funerals. All other farmers considered the crop as not worth harvesting. Germination and vegetative growth was reasonable, but a combination of the lateness and poor distribution of the rains and heavy aphid infestation led to very low yields. The failure of the main field crops, particularly maize and groundnuts, caused farmers to pay early attention to their vegetable gardens.

Figure 3. Example of participatory budget showing planned activities, resource use and outputs for a tomato farmer, Tano district, Ghana

Cash given in Ghanaian Cedis (1 US dollar = 2,250 Cedis)

DRY SEASON TOMATO PRODUCTION, 2 fields A) and B). Mr S.A. (Dwomo Village) 4 acres - Family Land **PB PLAN**

	September	October	November	December	January	February
ACTIVITIES.	Nursery (Field 'A') Land clearing Nursery (Field 'B')	Ridging Transplant A + Fert Re-ridge A + spray Land clear B	Ridging B Transplant B Fert A	Re-ridge B Spray A Fert B Harvest A Water B Spray B	Spray B Spray B Fert B Harvest B	
LAB. (people x days) (**Bold =** hired)	2hr 2x6 **2x2** 2x1 2x3 2x2 2x1	2x4 2x2 2x2 2x6 2x2 2x2 2x2 2x2 2x1	2x2 2x1 2x1 2x4 2x2 2x3 2x1 2x4	2x1 2x1 2x1 2x2 2x3 2x6 2x5	2x2 2x2 2x2 2x1 **3x2** **2x2** 2x2 2x1 2x6 2x6 2x6 2x1	2x2 **3x2** **3x2** 2x2 **2x2** 2x2 2x2

INPUTS

SEED 6 milk tins (3 bought + 3 own)
CUTLASS x 2
HOE x2
FERTILISER 2 bags 15-15-15 + 1 bag Urea
SPRAY HIRE Motorised 3000 Cedis per spray * 8 = 24,000
CHEMICAL Insecticide: 2 litres
Fungicide: 3 paint pots Diathane, 30 sachets Kocide

YIELD (all produce sold)
A: 35 boxes @ 40000 = 1,400,000
B: 35 boxes @ 50000 = 1,750,000
TOTAL (70 boxes) = 3,150,000

CASH (Cedis)

SEED 12000
CUTLASS 12000
HOE 7000
FERTILISER 105000 (15-15-15 = 80000, Urea = 35000)
INSECTICIDE 30000
FUNGICIDE 126000 (Diathane = 66000, Kocide = 60000)

TOTAL INPUT COSTS = 316,000

- Kocide used to improve leaf greenness
- Topsin encourages more flowering
- Urea is mixed with 15-15-15 and applied in solution because of dry season

The areas planted to maize by farmers were as planned. Broadly farmers planted at planned seed rates, with one using more seed than planned due to re-planting. Planting was done behind the plough. Three of the farmers planted different varieties from those planned. In two cases this was as a result of unavailability of the planned variety. In one of these cases, the seed type available was less appropriate than the one planned for, as it was a longer-season variety. In the third case the farmer followed advice to switch to a shorter-season variety. The farmers that did not change seed type simply used seed they had available, irrespective of the shorter season due to delayed planting. On the whole farmers' plans to apply fertiliser to maize were not fulfilled. Farmers did not buy fertiliser either because they had no cash, or cash saved was required elsewhere e.g. to pay school fees. Some anthill soil was applied but most plans were not fulfilled due to broken ox-carts or carts not being available as anticipated. One farmer applied ash as a fertiliser.

For groundnuts, planting dates were broadly as planned, as were amounts of seed used. One farmer planted a 30% larger area than planned as she had extra land and resources available. No gypsum was purchased. The farmer who had planned to apply this had given bambara nuts to her son to sell in Harare for him to purchase fertiliser for both maize and groundnuts. However, her son decided to use the money to buy cement instead.

Labour availability for both crops was affected by several factors. The late rains resulted in a number of crops being planted at the same time. This caused a labour bottleneck at the start of the season as well as later on in the season, particularly during weeding. If rains had arrived earlier, planting dates would have been spread out more, so that weeding of earlier and later planted crops did not coincide. Further limitations on labour occurred due to absent family members, illness, injury or pregnancy in the family. Social obligations associated with attendance at funerals affected all farmers, with some farmers being absent for up to one week for a funeral and some farmers attending more than three funerals during the season. Religious and traditional beliefs also restricted the days that farmers were able to work. Friday is 'chiefs day' ('chisi') when it is taboo to work in the fields and most farmers attend church on either Saturday or Sunday. In addition, farmers traditionally wait for three days after effective rainfall before planting. These factors all combined to severely restrict the labour available and the days on which field activities could be undertaken. Poor rainfall also affected weeding, as farmers only weeded in the early morning to minimise disturbance to the crop. There was an additional significant labour requirement to control 'roaming' cattle, particularly on more distant fields. The risk of crop damage from this resulted in some farmers harvesting crops early, and others planting later than intended.

Farmers' planning reflected a consideration of the expected labour requirements on the farm and labour bottlenecks. For example, one farmer planned to plant her maize in November so that weeding would coincide with Christmas when relatives would be staying. Actual availability and use of draught power varied considerably. In one case the farmer repaired a second plough and borrowed more oxen, using more draught power than planned. In another case the farmer acquired two more oxen. Some problems were reported with sick animals and one farmer reported delays in ploughing due to ox equipment breakages. The delayed rains and the resulting narrower time period for ploughing and planting affected

those without full control over draught power. This led to increased frustrations associated with waiting for the availability of shared draft animals.

Problems and constraints identified in ward 12, Buhera district, Zimbabwe

A number of problems and constraints affecting farmers in the season were identified through the process. These can be broadly categorised into biophysical constraints and socioeconomic constraints. Tables 1 and 2 summarise these problems, the number of farmers affected by them (out of the six involved in the exercise) and the causes and effects of the problems.

Most of the constraints have been discussed above and a brief summary is given here. Of the biophysical problems, poor rainfall was the most serious, affecting all farmers in the study. In addition to affecting crop yields directly, the impact on timing of activities was considerable, resulting in serious labour competition within and between farms when resources are shared. Poor and unpredictable rainfall is a common problem in dry land Zimbabwe, particularly in natural regions III and IV, and although the rains were particularly poor during this season they were by no means the poorest the farmers had experienced. The season was therefore not unrepresentative of farmers' experience as a whole although it better represented conditions and responses in a poor season. Most other biophysical problems focused on pests and diseases. Termites were the most serious problem in maize and sunflower, resulting in lodging of plants. Aphid infestation was the most serious in groundnuts, resulting in groundnut rosette virus affecting some farmers.

The main socioeconomic constraints related to impacts on labour availability. For example, attendance at funerals affected all farmers, and illness or pregnancy of family members affected three out of six farmers. Even one person in the family being ill significantly delayed many farmers' activities. Lack of cash also affected most farmers, affecting input levels and the hiring of labour to carry out activities on time. One farmer could not raise cash as planned, as there was a ban on the sale of cattle due to an anthrax scare. Delayed availability of draught animals also affected two farmers, impacting on planting dates and labour demand.

Most problems affected farmers from a range of wealth levels, but those without control of their own draught power were most affected by delayed access to draught power. No other differences between the wealth levels were apparent, probably due to the low sample size of farmers. It is interesting to note the interaction between the biophysical and socioeconomic problems experienced by farmers. The most striking of these is the interaction between rainfall and labour demand.

Table 1. Biophysical problems identified through participatory budgeting process in Buhera district, Zimbabwe

Problem / constraint	Farmers affected* (n=6)	Cause of problem	Impact of problem
1. Poor rains - late arrival, low quantity, and poor distribution	6		Delayed land preparation and planting resulting in competition for labour later in season Low moisture levels in soil and low yields
2. Sickness of draught animals	1		Delayed land preparation
3. Termite damage (maize & sunflower)	3		Reduced yields, damaged cobs, lodging of plants
4. Lodging of maize	1	Termites and high winds	Damaged crop and low yields
5. Aphid infestation (groundnuts)	3	Prolonged dry spell	Reduced yields
6. Groundnut rosette virus	1	Late planting of crop	Reduced yields
7. Fungal disease on groundnuts	1	Wet period in season	Reduced yields
8. Poor soil fertility	1	Cannot afford fertiliser	Low yields
9. Bird damage	1		Reduced yields
10. Mice damage	1		Reduced yields

*This represents the number of farmers who specifically identified the problem. It is likely that other farmers were also affected by the problem but did not raise it as an issue.

Table 2. Socioeconomic problems identified through participatory budgeting process in Buhera district, Zimbabwe

Problem / constraint	Farmers affected* (n=6)	Cause of problem	Impact of problem
1. Unavailability of seed variety	2	Poor market supply	Inappropriate variety planted - low yields
2. Poor quality seed**	1	Unreliable supplier	Poor germination and low yields
3. Lack of cash, or cash diverted e.g. to pay school-fees.	5		No fertiliser applied; different crop planted than planned due to seed cost; no weeding carried out; no seed for gap filling.
4. Broken equipment e.g ox-cart, yoke	2	Cannot be replaced as no money	No application of anthill soil
5. Ox-cart unavailable	1	Others using it - competition for use as rains delayed planting	No application of anthill soil, delayed transport from field.
6. Illness and pregnancy of family members	3		Reduced labour available resulting in delayed activities
7. Funeral attendance	6	Social obligation	Delayed activities
8. Ban on sale of cattle	1	Anthrax scare in area	Lack of cash to buy inputs etc.
9. Delayed availability of draught animals	2	Caused by not owning cattle and accentuated by competition for animals due to delayed rains	Delayed land preparation
10. Roaming cattle (damage particularly to remote fields)	3	No fences; lack of social organisation to control cattle.	Crop damage, increased labour requirement to guard plots; fear of planting early; harvesting early
11. Labour competition	6	Planting of crops at same time so weeding coincides. Obligation to provide labour to family members	No weeding of some crops resulting in low yields

* This represents the number of farmers who specifically identified the problem. It is likely that other farmers were also affected by the problem but did not raise it as an issue.

**This is classified as a socioeconomic problem due to the direct cause of the problem.

The study clearly demonstrates the risky nature of farming in dry land Zimbabwe, as noted by Scoones, Chibudu and Chikura et al. (1996), and the complex interaction of factors which need to be managed by the farmer in response to influences, both biophysical and socioeconomic, outside his or her control.

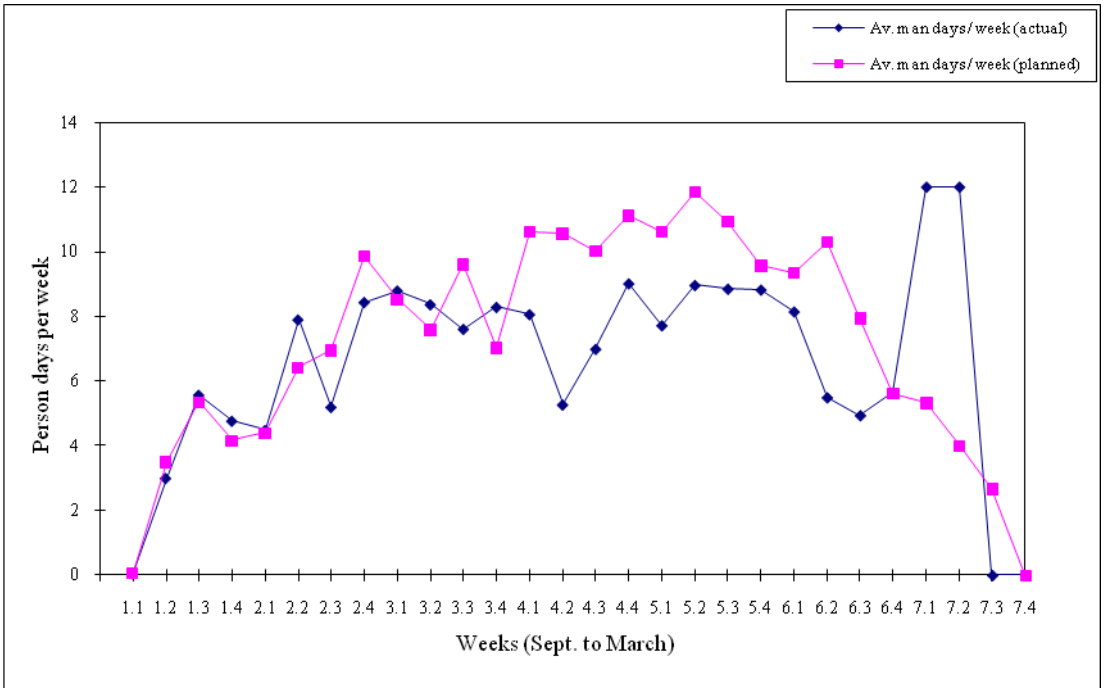
Timing of activities in Tano district, Ghana

The larger sample size in Ghana enabled more detailed analysis of results to be conducted. Timing of activities, labour used, production costs, and harvested yield and income are considered together with the constraints identified. There were some important changes in timing although generally actual timing of activities were as planned. There were some major differences in labour use in comparison to planned (see later section). The main biophysical causes of activities not being carried out included extra rainfall reducing watering and spraying (13 farmers), and no weeding and spraying being undertaken as it was not necessary (three farmers). Socioeconomic causes of activities not being undertaken included lack of buyers (eight farmers) and resources being diverted to other enterprises. Biophysical causes delaying activities included rainfall, hard ground, 'ineffective burning' and changes in timing due to different varieties from expected being grown.

Labour profiles in Tano district, Ghana

Figure 4 shows the average planned and actual labour profiles. Labour figures were recorded as number of people and number of days. Often activities take less than one day and therefore the figures for labour given are not precise. However, comparisons between periods can be made and general trends highlighted.

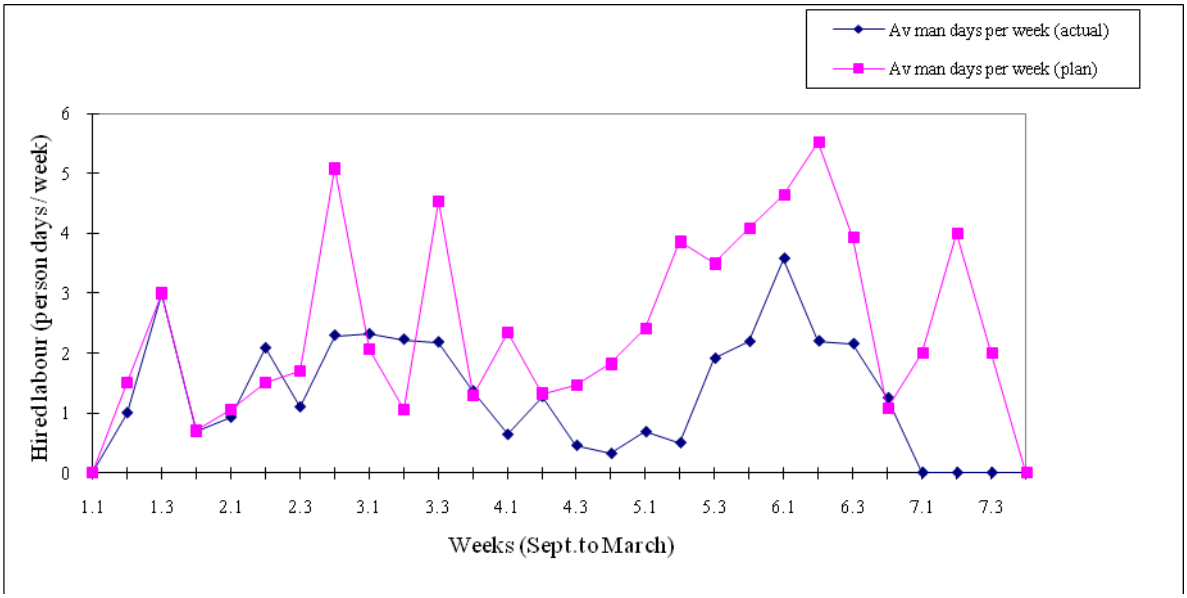
Figure 4. Graph showing average planned and actual labour profiles for 22 tomato farmers, Tano district, Ghana



The graph shows that estimates of labour requirements were quite accurate up to week 2.1 (first week of October). From the beginning of December (week 4.1) planned labour was higher than actual labour requirements, with the exception of weeks 7.1 and 7.2. This anomaly is caused by only one farmer being active at this time and requiring 12 labour days for harvesting. Planned labour requirements were higher during this period as farmers expected to be using labour for harvesting, but the lack of market in this year resulted in less labour being required during the harvesting period. A further factor was that rain during this period reduced the labour required for watering.

Periods of highest planned labour requirements were between week 4.1 (December) and week 6.2 (mid February) when watering, spraying and harvesting activities are taking place. Two broad periods of actual peak labour occurred. These were between week 2.4 (November) to 4.1 (December) and week 4.4 (late December) to 5.4 (late January). The initial peak is caused by the activity of ridging, often combined with application of fertiliser. Transplanting also occurred at the start of this period. The second peak is attributable to the start of the harvest.

Figure 5. Graph showing planned and actual hired labour profile for 22 tomato farmers, Tano district, Ghana



Only one farmer did not plan to hire any labour. The amount of labour farmers planned to hire over the season varied greatly from over 100 person-days to fewer than 10. Figures for planned hired labour are generally higher than actual labour hired, particularly later in the season. Only two farmers hired more labour than planned, due to family sickness and additional unexpected activities. Five peaks are apparent in the planned profile. One farmer giving particularly high figures for ridging causes two of these (weeks 2.4 and 3.3). The peak in week 7.2 is caused by only one farmer being active and planning to hire four people to help with the harvest. The peak in week 1.3 is due to land clearing, which is often done using hired labour. A further peak occurs in week 6.2 when most farmers are harvesting. Three peak

periods can be identified in the actual labour profile. A peak occurs in week 1.3, as planned, due to land clearing. Labour is also hired during the period 2.2 to 3.3 when ridging and re-ridging is being undertaken. A peak also occurs in the period 5.3 to 6.3, similar to the planned profile, due to the hiring of labour for harvesting.

Overall the general pattern of the actual hired labour profile is similar to the planned profile. This is to be expected, as there are certain activities which farmers prefer to do themselves (transplanting, spraying and application of fertiliser) and others for which they prefer to hire labour (ridging and land clearing). Labour is also hired when an activity needs to be carried out quickly and there is insufficient family labour available to do this, for example at harvest time.

Changes also occurred between planned and actual labour types. All changes in labour type were attributed to socioeconomic causes. Hired labour replaced family labour when there was illness in the family or when family members were unavailable for other reasons (five farmers). The primary cause of farmers using family labour rather than hired labour was due to a lack of cash (four farmers). This included instances when cash was diverted to other enterprises or other needs. In two cases additional family labour became available due to family members arriving back home unexpectedly.

Inputs and production costs in Tano district, Ghana

Farmers treated all production costs essentially as variable costs. This included tools, which were bought new each year and used primarily for the tomato crop, and labour, which was hired on a daily basis. For this analysis, production costs are divided into land hire costs, costs of inputs (primarily fertiliser and chemicals) and costs of hired labour (already discussed in the previous section).

Land hire costs varied considerably between farmers. The lowest rate per acre was 7,000 Cedis and the highest 48,000 Cedis per acre depending on factors including proximity to a perennial water source, good soil fertility, proximity to the road and type of vegetation to be cleared. Main purchased inputs included fertilisers, chemicals (fungicides and insecticides), tools, seed and other costs such as sprayer hire. Farmers intended to buy fertiliser, tools and seed prior to the start of the season and chemicals during the season when they were required. Relative expenditure on each of these inputs varied between farmers but generally, highest actual expenditure was on fertiliser and chemicals. Seed costs were very low with only seven farmers buying seed. Purchase of seed was generally as planned by farmers. Tools bought by farmers consisted of hoes and cutlasses. All farmers planned to buy tools and actual expenditure on tools was broadly similar to planned expenditure.

Farmers' main input costs related to fertilisers and chemicals. All farmers planned to use both fertiliser and pesticides, however the application rates and total expenditure on these items varied considerably between farmers. The most commonly used fertiliser was 15-15-15 and generally farmers only applied one type of fertiliser. Application rates per acre varied considerably. Ten farmers used some sort of foliar fertiliser. Fertiliser was generally applied in solution during watering to promote easy uptake by plants. Due to unexpected rains in

December some farmers applied fertiliser as granules. Overall fifteen farmers used less fertiliser than planned, four used more and three used the amount planned. Changes from plans reflected changes in farmers' decisions in the light of more detailed knowledge on site soil fertility status which was not known at the planning stage. Reductions in fertiliser applications also occurred due to cash constraints (two farmers) and to avoid excessive vegetative growth (two farmers.

All farmers planned to apply fungicide to the crop and only one did not. All except one farmer applied Diathane M45, but at varying rates. Only three farmers applied within the recommended rate (480 - 960 g a.i. / acre), but all three applied an additional fungicide as well. All the others applied well above the recommended rate, the highest being 3,760 g a.i. / acre, most applying an additional fungicide as well. Spray frequency also varied but was generally within the 7 - 10 day intervals recommended. One farmer applied four different types of fungicide.

All except one farmer applied one type of insecticide, the most common being 'Karate'. Chemicals were generally mixed together and applied as a cocktail. This helped to reduce labour involved in the application process. The majority of farmers exceeded the recommended application rate. Nine farmers applied chemicals as planned. Six applied more than planned due to high incidences of insect attack, and seven applied less than planned. Reasons for this included the low incidence of pests and diseases, and rainfall in December reducing the spraying period.

All farmers planned to grow at least half an acre of tomatoes. The largest planned field size was four acres. The majority of farmers planned to grow between 0.5 to 1.5 acres. Two farmers reduced their planned field size due to them having insufficient cash available to hire labour and a lack of labour for ridging. Differing field size and input levels between farmers reflected differences in site-specific resource demands and the availability of these resources to farmers. Individual farmers' input levels and field size varied from year to year depending on resource availability and field site. Field size was governed primarily by soil fertility status and farmers' cash availability to purchase fertiliser, as well as by labour considerations. If soil fertility at a site was relatively poor, it meant that higher fertiliser application rates were required, resulting in the farmer only being able to farm a small area.

Labour considerations were also important in determining field size. Sites close to water, or for which only part of the field needed regular watering, allowed the farmer to grow a larger area. In the same way, a low weed incidence allowed the farmer to grow a larger area. Watering and weeding were seen as the main labour considerations as they were undertaken by the farmer himself rather than by hired labour. The differing production strategies are therefore a result of a complex interaction of factors relating to the varying resource demands of different field sites and the variations in resource availability between farmers.

Overall, actual fertiliser and chemical costs per acre increased from original plans for six farmers and decreased for 15 farmers. Only one farmer's costs were the same as planned. Of the six farmers whose costs per acre increased, two of these had reduced their field sizes,

and decreased field sizes for these farmers may have resulted in more funds being available to buy inputs. Farmers' increased costs per acre were generally attributable to increases in expenditure on fertiliser, although increases in expenditure on chemicals occurred with unexpected pest outbreaks. Most farmers' (18) actual total expenditure was lower than their planned total expenditure. Three farmers' expenditure was higher than planned. The average increase in costs was 33.6% of planned costs (s.d. = 22.68, n = 3) and the average decrease was 39% of planned costs (s.d. = 18.7, n = 18). A number of factors influenced this, including farmers responding to biophysical conditions of the crop and environment as a whole and changes in socioeconomic conditions such as unexpected changes in resource availability of cash or labour. These differences in planned and actual costs reflect farmers' adaptations to unexpected events occurring throughout the growing season.

Harvested yield and income in Tano district, Ghana

The marketing system for tomatoes, although informal, is highly organised. Traders, who are mainly women, travel to the producing areas from the main market centres of Kumasi and Accra to purchase tomatoes direct from the farmers. The tomatoes are then sold to retailers in the main markets, the system being controlled by 'market queens' (see Lyon, 1997 for a detailed description). Traders bring crates or boxes that are distributed to the farmers for harvesting the same day. Payment is made per box harvested. Prices fluctuate dramatically on a daily basis and, within the main markets, even within a day. Prices are generally agreed with farmers prior to harvesting but the system of negotiation varies from area to area and on the relative levels of supply and demand which determine the strength of the buyers' and sellers' bargaining positions. Often relationships will be built up over time between specific traders and farmers to the benefit of both parties.

Farmers only harvested tomatoes once a buyer had been secured and a price agreed. The figures given for actual yield therefore represent the quantity of tomatoes harvested rather than the quantity produced in the field. Many farmers commented that fruits were left to rot in the field due to a lack of buyers. On average farmers harvested 55% less boxes than planned. Only one farmer harvested more boxes than he had planned. Farmers attributed this to a lack of demand for tomatoes resulting in few buyers and boxes. Other factors affecting harvested yield mentioned by farmers included excess rains resulting in poor crop performance, drought resulting in harvesting ending earlier than planned and fruit cracking.

The lack of demand for tomatoes was also apparent due to the low prices received by farmers when they did manage to sell some of their crop. All farmers received a lower price than they had indicated on their plan. Price fluctuations were reported to have been more extreme this year than usual. The highest price actually received was 34,000 Cedis per box compared to 75,000 Cedis per box the previous year. The average price expected by farmers was 52,800 Cedis per box, with the average actually received being 20,860 (s.d. = 5,745 n = 22).

Both the low number of boxes sold and the low prices affected farmers' income and all farmers received a considerably lower income than expected in their plans. Four farmers made an overall loss, the highest loss being 273,750 Cedis. Eighteen farmers had a positive

final cash balance[1] at the end of the season but this was highly variable between farmers (mean = 459,478 Cedis, s.d. = 416,520 Cedis, n=18). Seven farmers had a final cash balance of over 500,000 Cedis, the highest of which was 1,320,950 Cedis. This farmer grew two acres of tomatoes and managed to sell the most boxes. Of the seven farmers who received the highest final cash balance, five of these also had the highest income, which emphasises the importance of marketing. Two others had reasonable incomes but were not in the highest seven, indicating that other factors also had an influence on final cash balance.

Farmers attributed the marketing problems to overproduction in the country. The lack of buyers was attributed to the fact that there are many areas closer to Kumasi, which have started to grow tomatoes, attracting buyers away from the more distant traditional tomato growing areas. Farmers also commented that the market awareness of tomato growers' is increasing and growers are trying to coincide harvest with peak prices. This has resulted in lower prices and more competition. However, in a scoring exercise comparing the market for this season with the previous fifteen years, the farmers indicated that the season was fairly average and by no means the worst they had experienced. However, prices were reported to be lower than in the last two years when prices had been particularly good.

Problems and constraints identified in Tano district, Ghana

Table 3 summarises the problems identified through the comparison of planned and actual activities and resource allocation of farmers.

Marketing problems affect all of the farmers included in the study. Even those with contacts with traders sold many less boxes than they had planned, due to the lack of buyers. Very few buyers came this year despite some farmers clubbing together to send someone to fetch them from Kumasi. A related problem was the low prices received by farmers.

Farmers' opinions on possible strategies to overcome this marketing problem differed. Options given included diversifying into other crops and better planning to coincide production with higher prices. It was apparent from the discussion that the farmers recognised that tomato production was a highly risky business due to the unpredictability of the markets, but if the price is good and buyers come to the area then as an enterprise it can be highly profitable.

Illness or pregnancy affected 17 % of farmers during the season. This resulted in delayed activities and more labour being hired to undertake those activities affected. Three farmers were also prevented from undertaking activities due to their attendance at funerals.

Shortage of cash was also experienced by 13% of farmers. Two farmers responded to this by using their own labour rather than hiring labour. Three farmers were unable to apply their planned inputs due to the unavailability of those specific inputs. However, they were able to buy alternatives. Two farmers had to hire spraying machines as their own were broken, resulting in increased cost and inconvenience.

[1] This figure does not take into account family or personal labour, but farmers refer to it as 'profit'

Table 3. Problems identified through participatory budgeting process in Tano district, Ghana
NB. Problems 1 to 8 are socioeconomic, problems 9 to 13 are biophysical.

Problem	% of farmers affected (n=22)	Month occurring	Cause of problem	Effect / Impact of problem	Farmers response
1. Funeral attendance	13%	Various	Social obligation	Activities delayed	None
2. Inputs unavailable	13% (9% fertiliser, 4% chemicals)	November	Input supply problems	Inconvenience and change in cost	Bought alternative
3. Lack of buyers for tomatoes	100%	January - March	Too many growers, lack of demand	Fruits rot in the field. Loss of income for farmers. Reduced labour at harvest	Travel to Kumasi to attract buyers
4. Low price for tomatoes	100%	January - March	(as above)	Low income (& profit for farmers).	None
5. Equipment broken	9% (sprayer)	Various	-	Increased costs; inconvenience	Hire alternative
6. Illness / Pregnancy	17%	Various	-	Activities not undertaken, delayed, or take longer	Hire labour; use children
7. Lack of cash	13%	Various	-	Increased costs; smaller area cultivated; reduced inputs	Farmer uses own labour instead of hire. Farmer reduces acreage grown
8. Distance of farm from road	4%	-	-	Higher labour cost at harvest	None
9. Farm burnt by wild fire	9%	February (dry period)	-	Reduced harvest	None
10. Insect Pests	9%	December	-	Crop damage	Increase pesticide application
11. Mid-season dry spell	13%	End of January / February	-	Harvest ended early	Increased watering required
12. Excessive rains	9%	January	-	Flower drop and poor fruiting. Flooded fields	Farmers drained fields where necessary.
13. Fruit cracking	4%	February	Poor quality variety	Harvest stopped early	Farmer used fruits for seed

The biophysical problem affecting most farmers was that preliminary rains did not start at the usual time and the end of January and the beginning of February were dry. As a result three farmers ended their harvesting early. This also resulted in increased watering being undertaken. Unexpected rains in December and early January affected two farmers. Poor fruiting was attributed to these rains combined with unusually high temperatures for this time of year. This resulted in a high rate of flower abortion and the scorching of plants.

Two farmers also identified greater than expected insect attack in December and increased their rate of insecticide application as a result. Two farmers were also affected by wild fire destroying part or their entire farm during the dry period of February. This risk was increased as farmers had shaded their tomato crop with dry palm fronds.

A number of problems were identified by the researcher due to his on-going interaction with farmers. These are not included in the evaluation of the method as they are not a result of its use but are nevertheless included here as important problems facing farmers in the area. A major problem related to farmers' poor knowledge about chemicals leading to inefficient use and potential health problems. A wide variety of chemicals were used, with some farmers using more than one chemical with the same active ingredient. Application rates and techniques and the frequency of application varied considerably between farmers, particularly for Diathane, the most commonly used fungicide. Instructions on the containers, where they still existed, were often in French as the chemicals were imported from the Ivory Coast. In addition chemicals were usually bought on a retail basis and therefore were not in their original bottles. Farmers used no safety equipment when applying chemicals. Other problems noted by the researcher included producers losing out due to fixed prices being paid even for larger boxes of fruits, declining soil fertility as identified by landowners and extensive use of poor quality seed.

Farmers' evaluation of the approach used

Farmers' reactions to the use of the methods were assessed through group and individual discussion after the end of the exercise. In Zimbabwe all farmers managed to use participatory budgets and resource allocation maps easily, despite a wide range of literacy levels. Of the six farmers involved, four observed that the methods had helped them to monitor progress, three that they enabled better allocation of resources (especially in a drought year) and three that they improved planning by helping develop a clear plan at the start of the season, which could then be amended. The methods enabled farmers to react better to the unpredictable events, by helping them to visualise the impact of their activities later on in the season and helping them to allocate their resources in the light of this.

Individual farmers' comments from Ghana are summarised in Table 4. A number of the points made by the farmers are interrelated. Almost all farmers mentioned the benefit of quantifying resources and the calculation of profit or loss. This is not surprising, as dry season tomato production is a market-focused enterprise. Farmers mentioned that the participatory budgets would help in future planning and that the recording was particularly helpful for increasing awareness of price trends during harvest and of family labour. Farmers also mentioned that the methods could be useful in comparing different enterprises.

Table 4. Farmers' individual responses to the methods used, Tano district, Ghana

Reaction / Comment	No. of farmers (n=22)	Comments
1. Identifies and quantifies resources used	21	Farmers particularly noted quantification of chemicals and labour used. One farmer noted that this quantification helps to guide decisions regarding future acreages to be grown
2. Estimates profits and losses	20	Farmers noted that this can be discouraging, but is a very important benefit of the method
3. Easily understood even by non-literate farmers	14	Most farmers were at least semi-literate but had used the methods to communicate with less literate family members
4. Serves as a record	11	Two farmers mentioned they could use the plans as a 'testimonial' to seek employment in a tomato enterprise. Another two farmers mentioned that the record would help in future planning
5. Accounts for labour used	7	Farmers who previously kept records did not include family labour
6. Helped to adjust future cropping patterns and plans	6	Farmers felt that the process had helped in planning, control, making adjustments within the season and informing future decision-making
7. Increased awareness of price trends during harvest	2	

All 22 farmers mentioned that being involved in the exercise had improved the timing of their field operations by helping them to keep to a plan and a pattern of work. They appeared to view this as a benefit rather than as an imposition, but this effect does mean that the picture gained from the exercise in terms of farmers 'normal practice' is not entirely accurate. One example of this given by one of the farmers was that usually, if he did not have the cash to pay someone to carry out a particular task, he would have left it until the cash was available. However, because of the plan and follow up, instead of delaying the activity he undertook it himself. The impact of the monitoring of farmers' activities and labour on farmers' behaviour has also been noted in other studies (e.g. Leesburg and Valencia, 1992). If the farmers are able to express how the exercise influenced their activity, as occurred in this instance, these changes in behaviour can be accounted for in the final analysis. Although this influence may affect studies on farmers' behaviour, it is unlikely that it will greatly affect what constraints are identified.

Discussion

The exercises in both Zimbabwe and Ghana were undertaken with the purpose of identifying constraints faced by farmers and to evaluate the usefulness of participatory budgets for exploring farming practices and resource use with farmers. Tables 1 to 3 summarise the problems identified. In Zimbabwe, 21 specific problems were identified, 11 of which can be classified as socioeconomic and 10 of which are biophysical. In Ghana 13 problems encountered by farmers were identified in the course of the season, seven of which can be classified as socioeconomic and six of which are biophysical.

The study also demonstrated the management constraints and wider livelihood issues within which innovations must operate in order to be appropriate. Several of the problems highlighted through the process, e.g. attendance at funerals disrupting timing of activities, may have been identified through one-off short-term studies, but the extent to which this is a problem and the nature of its impact would not have been identified. The process enabled both the farmers and the researchers to assess the impact and extent of these factors upon the farm. The advantages of the exercise included improved understanding of the socioeconomic constraints and their seasonal nature as well as insight into the direct impact and the knock-on effects of the problems identified on farmers' enterprises. The process also highlighted the responses of farmers to these constraints in terms of the management of their resources and overcame the problem of seasonal bias as it involved sequential visits over time. The limitation of only focusing on one season was addressed to an extent through discussions with farmers about the representativeness of the specific year studied. The fact that, although farmers may plan, or have an intention in terms of the timing of activities and resource use, these plans are inevitably disrupted by unforeseen circumstances is demonstrated clearly. The exercise therefore helped to demonstrate the rationale and the social context of farmers' sequential decision-making (Richards, 1989) through the season.

The effectiveness of formal research in addressing the socioeconomic problems identified is likely to be limited as they result from lack of access to resources, cultural obligations and external logistical constraints. Of the biophysical problems identified, all could be addressed by research in some degree, however, on the whole, technically effective measures are already available to overcome these problems. Whether they require research and can be classified as researchable constraints is therefore doubtful, although research into more appropriate measures and technologies may be necessary.

The wider benefits of the approach to both farmers and outsiders indicate its potential in other contexts (Galpin 2000), particularly extension. A major benefit to farmers was the on-going interaction with a knowledgeable outsider. This led to a relationship being built up between the researcher and the farmers and the sharing of individual strategies, approaches and problems. Knowledge gaps were identified and information was provided to farmers when it was needed. Outsiders in turn benefited from an improved understanding of factors affecting farmers' decision-making and the social, environmental and economic constraints that farmers are operating under. The approach could also lead to the realisation by facilitators / extension staff that lack of knowledge is often not the key problem but that farmers' adequate knowledge is often frustrated by poor resource availability or lack of control over resources, and external social and environmental factors,. This has the implication that the role of extension should involve facilitation of farmers' strategies for change as advocated in participatory and farmer-led extension approaches (Hagman et al 1998, Scarborough et al 1997) and that use of participatory budgets could play a useful role in this. Other uses of participatory budgets but in shorter on-off exercises are described in Galpin et al (2000) and Dorward et al (2007) and include comparing different enterprises, exploring the implications of making changes to an enterprise, and planning a new enterprise.

Variability within seasons is expected to increase as part of climate change. Exploring with farmers how they could further adapt their activities is likely to involve considering different scenarios and

taking into account the responsive and sequential nature of farmer decision making. Participatory budgets may provide a useful tool for this.

Conclusions

The findings clearly demonstrate that farmers make many decisions and respond as conditions become clearer during the season. They also indicate that seasonality involves not just biophysical but socioeconomic factors and that frequently these are more influential on farmers' decision making and activities. Both these points have important implications for how seasonal variability and potential farmer adaptation strategies to climate change are viewed and researched. Participatory budgeting, either in long-term studies as described in this paper, or in shorter participatory exercises, appear to offer a useful additional method for achieving this.

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