WILDFIRE INCIDENCE AND MANAGEMENT IN THE FOREST TRANSITION ZONE OF GHANA: FARMERS' PERSPECTIVES

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ABSTRACT

Forests in Ghana are increasingly being influenced by man-caused fires. Most of these fires have been blamed on farmers practicing slash and burn agriculture. In addition, many critics have assumed that farmers have very limited knowledge of fire management and therefore do not manage farming-related fires. A survey was conducted in eight communities in the forest transition zone to assess the perceptions of farmers on farming-related wildfire incidences, specific activities in farming associated with incidence of wildfires and coping measures being used by farmers to manage wildfires. Farmers in the studied settlements hold the view that there are presently certain cropping practices that are closely associated with wildfire incidence. These include early vegetable and yam cultivation whereby the burning of slash takes place between December and February when fire risk is high. The study also found that farmers have useful knowledge in wildfire management and are applying it to cope with the impacts of wildfires. Some of the important coping strategies are farm maintenance practices, fire prevention education and precautionary measures during land preparation. Adopted measures by farmers need to be supported by research and agriculture extension to remove weaknesses in farmers' efforts.

Keywords: Wildfires, slash and burn agriculture, cropping practices, fire management strategies, farmers' perceptions

INTRODUCTION

From the global perspective, wildfires contribute significantly to environmental degradation including global warming (Zhengxi *et al.*, 2007). In Ghana, wildfires have become a major cause of forest cover loss and decline in agricultural crop production since the 1983 wildfires ravaged the semi-deciduous forest zone (Hawthorne, 1994; Nsiah-Gyabaah, 1996). The use of fire in slash and burn agriculture has been seriously criticized and blamed for the high incidence of wildfires. Slash and burn agriculture involves about 500 million people and affects about 240×10^6 ha of closed forest and 170×10^6 ha of open forest in the tropics (Goldammer, 1998). This is approximately 21% of the total tropical forest area (FAO/UNDP, 1982). Hence, many people with diverse professional backgrounds and interests blame fire use in agriculture for the rapid vegetation and soil degradation in the tropics **(**Greenland, 1975; Korem, 1985). Although the criticisms on the use of fire in agriculture has been persistent, fire usage in agriculture appears to exacerbate. Regrettably, alternative methods to the use of fire have not benefited much from research and scientific innovations. Jansen (1995) argues that scientists' views on burning are inconsistent. For example, while burning is often condemned in peasant farming systems, experiments are being conducted

into the use of fire as a new technique for clearing weeds and pests from fields, and stimulating plant growth in the United States of America. Hence, the problems involved in burning relate to the conditions under which it is used, the cultural practices and rationality of its use and not the actual technology of burning or not burning.

In most cases it has been assumed that farmers have limited knowledge in fire management or are not making any effort to curb the incidence of wildfires (Korem, 1985). Consequently, it has been suggested that farmers should be made to understand the value of organic matter in the soil and taught how to replace wasteful shifting cultivation with permanent cultivation so that they could be weaned off from the use of fire (Korem, 1985). However, the fact that farming is dynamic and is constantly fed by farmers' knowledge and perceptions, suggests that farmers might have developed some appreciable level of fire-related knowledge to enable them cope with increasing incidences of wildfires in the agricultural landscape.

Furthermore, besides the removal of slash, some clearly established direct benefits that accrue to farmers through the use of fire (Amissah, 2003; Ketterings *et al.*, 1999; Amanor, 1994) would retain farmers' interest in fire for a very long time.

This paper therefore examined farmers' perceptions on farming practices that contribute to wildfire incidence and how they manage agricultural fires as part of their coping strategy-response to the wildfire menace.

MATERIALS AND METHODS

Study Sites

The survey was conducted in eight forest fringe communities namely, Twumkrom, Taforo Anyinasu and Asuboi. The rest were Feyiase, Ahomahomasu Twumasikurom and Amanfoso. The population and number of households in each community are presented in Table1.

Table 1: Profile of communities surveyed for the study

Community	Population	Number of households
Taforo	457	107
Twumkrom	899	189
Twumasikrom	266	45
Amanfoso	89	22
Asuboi	660	126
Anyinasu Ahomahomasu	4,707	657
Feyiase	345	68
	477	96

Source: Ghana Statistical Service, 2005: 2000 population and housing census of Ghana

Twumkrom and Taforo communities are fringe communities of Pamu Berekum Forest Reserve located in the Dormaa Ahenkro district of Ghana. Twumkrom and Taforo have populations of 899 and 457 people respectively (Ghana Statistical Service, 2005). Major food crops grown are plantain, maize and cassava with yam and pepper being minor crops. Land is acquired through family or share cropping known as *abunu* and *abusa*. For *abunu* share cropping, the yield from the land is shared equally between the landowner and the farmer. The farmer provides all the inputs for the farm including the labour. This arrangement is normally done for oil palm plantations and cassava farms. In the *abusa* arrangement, the produce from the farm is divided into three parts. A third goes to the landlord and two-thirds to the farmer. Land is also given out on rent. The amount charged is negotiable between the owner of the land and the farmer. In 2001, an acre of land on the average cost between GH¢5 and GH¢6 per year. In Taforo, majority of the inhabitants own the land but the settler farmers rented an acre of land for two years at GH¢10.

Asuboi and Anyinasu are located in the Offinso District with populations of 660 and 4,707 respectively (Ghana Statistical Service, 2005). These communities are located at two opposite ends of the Afram Headwaters Forest Reserve. Asuboi shares a boundary with the reserve. Part of the village has now moved beyond the boundary into the reserve. The population of farmers has increased because more land has become available for food crop cultivation as a result of the destruction of cocoa farms through wildfires and senescence. The majority of people living in Asuboi are natives, though there are quite a number of settler farmers. The major occupation in both communities is farming and the major crops grown are maize, groundnut, yam and onions with plantain and cocoyam being minor crops. Asuboi is the leading producer of onion in the district and used to be a major cocoa producing area but suffered from the 1983 and subsequent wildfires. Land is acquired for farming through renting from the indigenes at GH¢ 4 per acre per year and through *abusa* share cropping system as of 2001.

In Anyinasu, bushfires occur annually, burning most fallow lands and therefore most farmers do not have to re-burn their slash, which is an advantage to them. The annual occurrence of bushfires together with tree stumping practices associated with mechanised cultivation has encouraged the growth of grasses especially elephant grass *(Pennistum purpureum*). Land acquisition is through renting (GH¢5 per year) for an acre and the *abusa* share cropping system.

Feyiase and Ahomahomasu are located within the Begoro District of the Eastern Region and are fringe communities of the Worobong South Forest Reserve. The population of these two communities is 477 people and 345 people respectively with most of the inhabitants being settlers. The major crops grown are maize, cassava, plantain, yam, pepper and tomato. Land acquisition is by renting (GH¢5 per annum), share cropping and individually owned lands. Some of the farmers also participate in the taungya programme under the supervision of the Forestry Services Division of the Forestry Commission of Ghana.

Located in the Sunyani District, Twumasikrom and Amanfoso are typical farming communities at the periphery of Tain Tributaries Block II Forest Reserve with a population of 266 and 89 people, respectively (Ghana Statistical Service, 2005). Access to land is through renting and share cropping. The natives' in the community farm on family lands or individually acquired lands. However, the settlers have access to land through share cropping and hiring. The cost of renting an acre of land for a year was GH¢6 as of 2001.

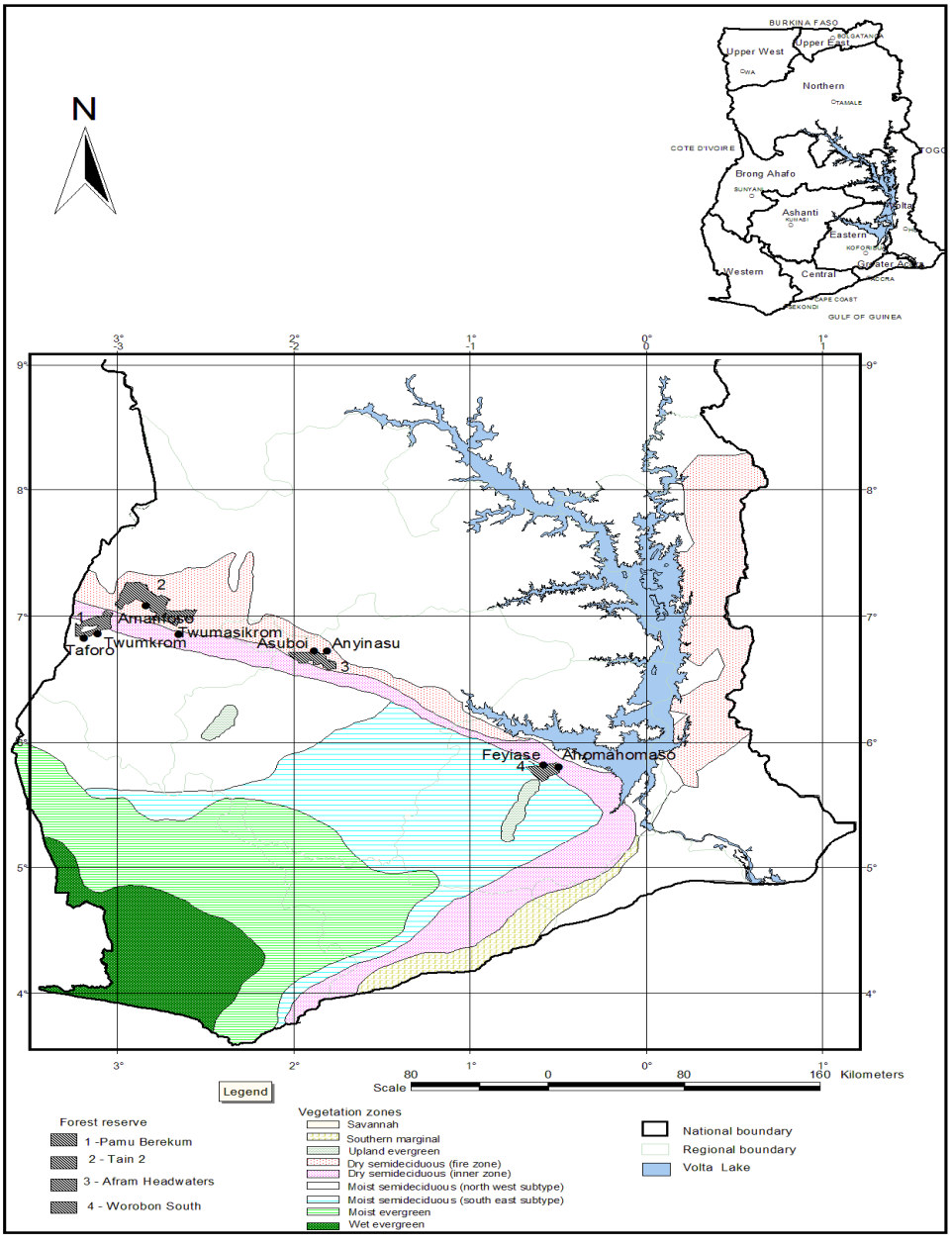

Figure 1: Map of Ghana showing communities (Twumkrom, Taforo, Feyiase, Ahomahomaso, Asuboi, Anyinasu, Amanfoso and Twumasikrom.) surveyed from Forest Reserves.

Data Collection and Analyses

Fifteen respondents were selected randomly in each community. The target group was farmers who had been in farming for ten years and above. Before the selection of the respondents all households in each community with a farmer who had farmed for ten years and above were identified and numbered with the help of opinion leaders and elders in the community. The total number of respondents for the four districts was 120 out of 1396 household units and a total population of 7900 people. Of the 120 respondents, majority (63.3%) were males and 36.7% females. Forty five percent of them were natives of the communities surveyed whilst 55% were settlers. The majority of the respondents were between ages 46-60 years following a normal distribution curve (Figure 2).

Primary data were collected from interviews, informal discussions and field observations and secondary data (information on forest-fringe communities) through desk studies at the District Assemblies and Ghana Statistical Services offices. Structured questionnaire was used to interview the respondents after it had been field piloted with five respondents in six of the communities to test its appropriateness. Informal discussions were also held with opinion leaders and chiefs for information on the general farming practices and general socio-economic activities in each community. On-farm observations were made to have a first hand experience on farming practices in the study area. An initial test did not show clear differences in the fire management practices of the individual settlements and so the data for all the settlements were pooled for the analysis.

RESULTS

Farmers' Perceptions of the Influence of Present Farming Practices on Incidence of Wildfires

According to the respondents certain types of farming practices in concert with inherent flammability of particular vegetation types predispose the environment to wildfires. The cultivation of vegetables like tomato, okra and pepper was considered highly associated with wildfire incidence followed by annuals such as yam, and to a lesser extent, perennials. Tree crops cultivation was adjudged to carry the least fire-risk. The reasons for these farmer perceptions have to do with the timing for land preparation for particular crops. According to 93% of farmers burning of slash for cultivation of vegetable crops takes place at a time when the fire risk is very high i.e. December–January (Figure 3) whilst for tree crops burning is delayed till March or beyond after the first few rains.

How Farmers Manage Agricultural Fires

Managing agricultural fires basically involves the practising of safe burning of slash. Burning is an art that requires a lot of skill. The factors farmers take into consideration before burning include the time of burning (safest month of the dry season), the type of fuel to be burned, number of people to assist in the burn, the fire-danger rating indicators and procedures to be observed before ignition takes place.

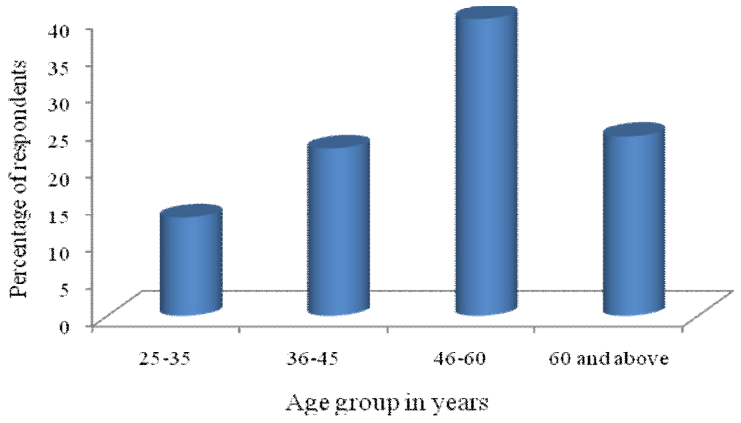

Figure 2: Age distribution of respondents in eight farming communities in the fire-prone forest belt of Ghana

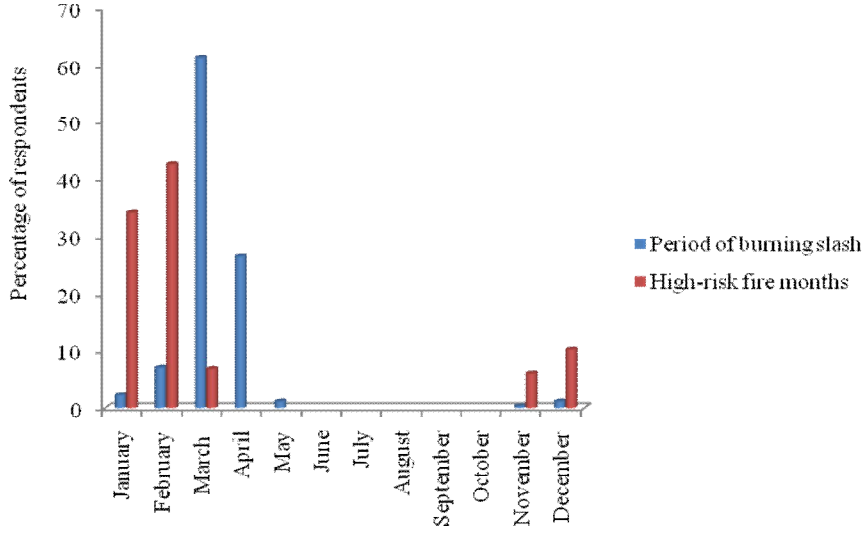

Figure 3: Period of burning slashed vegetation as part of land preparation in the fire-prone forest belt of Ghana and months that farmers consider as high risk months for burning slash

Time of Burning

In order to achieve the objective for the use of fire in land preparation, the time of burning (month) was considered very important (Figure 3). The study indicated that most (61.1%) of the farmers burn the slash in March. This declined to 26.5% in April and 7% in February, whilst 5.5% burn in other months. The respondents perceive these months as critical for burning due to a number of reasons. The months of March and April are favourite times for burning due to a combined result of a good burn (near complete burn of debris) and reduced risk of fire escape. Burning in March and April was also for timely cultivation of crops at the onset of the rains and to prevent the re-growth of weeds before sowing of seeds and other planting materials.

Indicators used to guide burning of slash

In order to achieve effective burning and at the same time reduce fire danger or risk, farmers look out for certain environmental cues for the right time to burn. The major indicator for the right time to burn is number of rain events or extent of soil dampness after the dry season. Others include temperature, wind speed, proper drying of the slash and leaf flush of indicator tree species (Table 2).

Procedure for Burning Slash

The procedure for burning cleared slash has evolved over the years in the light of changes in vegetation and the incidence of rampant wildfires. Other changes have come as a result of local byelaws, the national policy on wildfire and the introduction of the village fire volunteer concept since the 1983 bushfire law (PNDC Law 229). A Chi square test indicated a significant change in the procedures for burning before and after 1983 (Table 3). The most significant change is the mandatory construction of fire belt before burning and supervision by fire volunteers (FVs) during burning. Respondents estimated that a crew size of 3-6 persons is normally adequate for burning an acre (0.4ha) of land but similar crew size is also used when burning larger areas.

Table 2: Environmental cues used to guide safe burning of slash in eight farming communities in the fire-prone forest belt of Ghana

Environmental cues used to guide burning	Relative frequency of response
After first rain	33.6
After 2-3 rains	23.1
After 4 rains	6.0
High temperature and heavy clouds	11.2
Low relative humidity	9.7
High temperature and high wind speed	4.4
Low temperature with low wind speed	4.5
Leaf flush of *Moris mesozygia*	1.5
When all the slash is dried	6.0

Total number of farmers reporting: 120

Table 3: Procedures farmers use for burning slash before and after 1983 in the fire-prone forest belt of Ghana

Procedure for burning	Percentage of Respondents		Chi square
	Before 1983	Between 1983 and 2001	
Construct fire belt and inform neighbour farmers	32.2	4.3	53.98
Construct fire belt and burn alone	49.6	12.8	30.67
Burn without fire belt	18.3	0	79.03
Construct fire belt and burn with family member	0	7.7	96.56
Construct fire belt and inform fire volunteers	0	75.2	72.15

The tabulated critical value at significant level 1% (P = 0.01) for degrees of freedom (d. f = 1) is, 6.63
Total number of respondents: 115

Firing and Burning Techniques used by Farmers

The burning techniques used by farmers before and after the 1983 wildfires are presented in Table 4. A Chi Square Test showed no significant difference between firing in strips and firing along with wind direction in the two periods. However, for other firing techniques such as firing against the direction of the wind and setting fire to heaped debris there were significant differences between the two periods.

The type of burning technique used by farmers does not appear to depend on the type of fuel, topography and weather conditions. Only about 3% of farmers indicated they take the type of vegetation into consideration before choosing the type of burning technique. Most of the respondents (88.4%) would burn on sloping land the same way they would burn on a flat land. However, a few would either burn from below the slope (10.6%) or from up slope (0.9%). Respondents had preferred weather conditions for burning (Table 5). Wind direction and speed is normally checked on site by throwing soil into the air or by watching the movement of leaves. Farmers have other techniques which they apply regularly for burning including construction of clean fire belt (100%), allowing for a few rain events (80%) and properly pressing the debris (32.5%) before setting fire to ensure a satisfactory level of burning. Generally the level of precautionary measures taken by farmers in handling fires depends on the value of the agricultural resources at risk. Most respondents (73%) indicated that burning close to cash crop farms such as cocoa or oil palm is carried out very carefully such that a fire belt of 2−3 m is constructed whilst for other crops about a metre width of belt is considered adequate.

Other Methods Adopted by Farmers to Manage Wildfires

In addition to measures taken at the site during burning of slash, other strategies are implemented by farmers in response to the wildfire problem. These are categorised as farm maintenance, precautionary measures during land preparation,

and fire prevention education. The farm management strategies are geared towards reducing fuel loading on the farm in order to reduce the intensity and spread of fire in case of fire outbreak. The main activities here are weeding of farms just before the dry season, preservation of trees to suppress weeds and reduce desiccation and the removal of dry plantain leaves from the stem. The education is done to warn farmers of high-risk periods and also encourage farmers to adhere to prohibition of burning and cooking in the farm during these high-risk periods.

Table 4: Techniques of burning slash in eight farming communities in the fire-prone forest belt of Ghana

Firing technique of burning of slash	Relative frequency of response		
	Before 1983	Between 1983and 2001	Chi square
Setting fire in strips	23.3	29.4	2.02
Setting fire spot by spot at regular interval	14.4	6.6	45.78
Set fire to move along with wind	22.3	28.0	2.52
Set fire to move against wind	14.4	21.8	15.73
Heaping debris and setting fire to debris	14.9	4.7	51.09
Setting fire around the edges of the farm	10.9	9.5	45.10

The tabulated critical value at significant level 1% (P=0.01) for degrees of freedom (d. f =1) is, 6.63.
Total number of farmers reporting: 115

Table 5: Weather conditions checked by respondents before ignition of slash in the fire-prone forest belt of Ghana

Preferred weather conditions at the time of burning	Relative frequency of response
High wind speed	14.3
Low wind speed	28.3
Moderate wind speed	3.0
High temperature	15.2
Low temperature	24.9
High relative humidity	4.2
Low relative humidity	10.1

Total number of farmers reporting: 119

DISCUSSION

Farmers' Perceptions of Farming Practices that Contribute to Wildfire Incidences

Farmers admitted that some of the practices they use in farming pre-dispose the environment to the incidence of wildfires. These practices are normally associated with the type of crops grown which in turn influences the decision to burn slash at a particular time of year. Respondents considered vegetable crops (tomato, okra, and pepper) as those whose cultivation is highly associated with incidence of wildfires. This is due to burning slash between December and February when fires are most likely to get out of control (Figure 3). Burning is normally banned by local laws during this period and farmers burn the slash in a rush for fear of being found out. Though it is generally perceived that these crops are often cultivated close to streams, in most cases the streams are dried up at the time of burning. Consequently any burning carried out without proper control may go out of the intended boundary resulting in wildfires. The wildfires are normally precipitated by prolonged dry season in some years as minor rains sometimes end in October and early showers delay until end of March through to April (Orgle, 1994).

Practices involved in the production of annual crops (especially maize and yam) were also cited as closely associated with incidence of wildfires. This is somehow expected since land has to be prepared for the cultivation of these crops on annual basis and also in the heat of the dry season (January to March) which increases the fire risk. Generally farmers who grow annual crops are less fire safety conscious because annual crops do not need protection against wildfires, as there are no standing crops in the field during the dry season. Furthermore, in most communities where land tenure is by share cropping and renting annual and short rotation crops are preferred and farmers in such circumstances have little interest in the long-term sustainability of the land. The respondents perceptions of the role of agriculture in wildfires is commendable because most often as noted by Arvai *et al* (2006) the public tends to emphasise uncontrollable factors when asked to consider the causes of wildfires. One positive aspect of the respondents' perceptions is that there may be prospects for collaborative research and fire management in the community.

Farmer Perspectives of Wildfire Management

It is often observed that farmers constantly adjust

their farming techniques and strategies to the problems, which emerge on their farms and their surroundings (Amanor, 1996). This observation applies to the findings of the present study. Not only do farmers perceive wildfires as serious threat to their farming activities, they have adopted measures to manage them. These, fall into three main strategies; measures to ensure fires used as a tool for land clearance do not easily get out of control, management of fuel load on farms and awareness creation/fire prevention education. What farmers perceive as fire management falls in line with scientific expectations in many respects.

Ability to confine a fire to its intended boundary depends on safe firing techniques and reduction of fire hazards. Fire spread is controlled through the use of fire belts which are most often constructed during burning of debris or when farmers are informed of incoming wildfires from a nearby farm, village or a forest reserve. The effectiveness of these belts which range from 2-3 m wide has not been well evaluated but the fact that farmers continue to use them means they often work. Korem (1985) recommends fire belts of 10-15m width for effective stoppage of fire but this may be sort of ideal and probably necessary only for forest conditions where canopy fires are involved.

Constant farm maintenance activities such as weeding, removal of dry plantain leaves from the pseudo stem are two very important activities which reduce fuel load and also keep human presence on a farm to improve on early fire detection.

Evolution of Fire Management over the Years

The process and techniques of burning have seen some changes over the years in response to the current fire regime. About 34% of the respondents indicated that there is significant change in the period of year when farmers burn their slash and about 90% would not burn their slash when the relative humidity is perceived to be low. This implies that respondents, recognised the time of burning as an important factor to consider before carrying out a burn. Most of the respondents now burn in March after the first rains and at the beginning of April (Figure 3). In addition, non use of fire on farms during the dry season and preservation of trees on farms are strategies being adopted by farmers. The preservation of trees on farm is not an entirely new farming practice. However, farmers are now using it for a different purpose; that of managing fuel load on farms. They explained that trees shade off weeds and reduce the extent to which fuels dry up on the farm. Many farmers are no longer using naked torches that were carried from home to the farm in the past instead the torch is lit on the site of the burning.

Before the 1983 wildfires, burning was carried out by the individual farmer most often with no assistance in contrast with the post 1983 procedure where the services of village fire volunteers are employed by about 72% of respondents (Table 3). At the same time the number of people who claim to construct fire break before burning rose from 81% to 100%. This is in recognition of the need to take extra precautionary measures to ensure that fires intended for land preparation do not get out of control. The number and level of training of people carrying out a burning exercise play important role in ensuring a safe burn and the achievement of the objective of the burn (Jansen, 1995). It is therefore positive development that most farmers seek the assistance of volunteers when burning in recognition of the present situation; where many of the forest areas have turned into grassland and *Chromolaena odorata bushes* resulting in rapid drying of fuel and increased fire hazard. The use of fire volunteer squads to assist farmers has been one of the good strategies to ensure fires used on farms are contained within the boundaries of the farm.

However, inadequate supply of tools and other forms of motivation for fire volunteer groups in the communities could serve as a disincentive to these groups and encourages individual burning which will be a set back to the nation's effort to curb wildfires.

The firing techniques used by respondents have changed slightly over the years. In Table 4, the number of respondents employing head firing and back firing has increased since 1983. However it appears farmers have learnt to use these safety methods but are unable to link them to fire hazard conditions under which their application is most recommended. For instance the majority (71.1%) of the respondents would not take into consideration the type of vegetation being burnt before choosing a corresponding weather and firing technique. Thus although there are certain vegetation types that are more sensitive to fire than others (Jansen, 1955), this was not reflected in the choice of techniques. A majority (88.4%) of respondents indicated they would also burn on a steep area the same way they would burn a flat area.

Other new techniques used by farmers are burning in smaller portions, proper pressing of the vegetation to prevent spot fires and burning against the direction of the wind. These are all measures that can reduce the risk of fire spread and yet have been developed exclusively by farmers without the input of external agents.

More recently the use of green fire break has been promoted by the Forestry Commission to reduce the spread of wildfires. However farmers interviewed were silent about this measure. This may be due to the fact that in most communities only a small number of the population was involved in this programme at the time of the study though it is likely that more farmers are now involved in green fire break establishment. Besides the establishment of green fire breaks take place in forest reserves and not on individual farms and this might have accounted for farmers' silence on its contribution to fire management at the community level.

CONCLUSIONS

Contrarily to popular belief that fire is used irresponsibly by farmers, our results show farmers have adequate knowledge of causes of agricultural-related fires and have developed strategies to cope with them. They admit that some of their activities such as burning in the heat of the dry season for vegetable cultivation and a lack of adequate knowledge in assessing the weather factors at the time of ignition contribute to fire incidence. However farming-related fires are managed with significant improvement in management strategies in response to the increased fire regime since the 1983 wildfires.

The supervisory role introduced by the fire volunteer concept during land preparation has helped to ensure that burning takes place within the acceptable time frame and is also attended to. Clearly farmers have a wealth of knowledge that can be incorporated into scientific fire management practices in Ghana. Hence their efforts need to be supported by researchers, agricultural extension officers and forest managers for further improvement and more effective fire management in the agricultural and forest landscape.

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