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Cropping Practices and Labor Requirements in Field Operations for Major Crops in Ghana

What Needs to Be Mechanized?

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ABSTRACT

This study examines the labor requirements associated with different cropping systems in Ghana in order to guide the prioritization of investments in mechanization in the country. First, major cropping systems are identified in the country by adopting the cropping pattern approach of Ruthenberg (1983), who defined farming systems according to the leading crop activities. Second, labor requirements and costs of production of crops in the various systems are examined at various levels of substitution of either herbicides or animal and mechanical traction for labor. We found that the total labor requirements varied among cropping systems. The requirements were particularly high in the two cocoa cropping systems in the forest zones. The requirements were particularly high for land preparation and crop maintenance. Looking across crops, land preparation and crop maintenance took the largest share of labor for cassava, yam, and maize. Rice, on the other hand, required large shares of labor for land preparation and harvesting. When all the systems are considered together, however, crop maintenance required more labor than land preparation.

In response to apparent unavailability and cost of labor, farmers are increasingly demanding mechanical traction for land preparation in Ghana. The benefits of mechanizing land preparation depend on both the system and the type of crop cultivated. Mechanization of land preparation for cassava in the vegetable belt, for instance, is more labor saving and cost effective than mechanization of land preparation for cassava in cereals belt. Within systems, there is also variation across crops. Where mechanization is not feasible for land preparation or not yet adopted for other field operations such as weeding, an alternative and common substitution for labor in crop production is herbicides. Herbicides are used to clear land for planting as well as to control weeds in standing crops. We found that where herbicide was used, its application reduced labor requirements for land preparation significantly. Selective herbicides were used to control weeds in all the crops examined and in all the belts except the vegetable belt. They also reduced labor use for weeding drastically.

Keywords: mechanization, cropping systems, labor requirements, Ghana, seasonal labor

1. INTRODUCTION

In order for Africa to climb out of agricultural stagnation, many development institutions, practitioners, and experts are convinced that, just as it was in Asian and South American countries, support is needed for investment in mechanization (Sims and Kienzle 2006; FAO 2010). Over the past three decades, however, not only has progress slowed down in agricultural mechanization in much of Sub-Saharan Africa (SSA), but also there is mounting evidence that progress achieved in the earlier years is being lost in many parts of the continent (Mrema, Baker, and Kahan 2008). In recent years, African countries under the Comprehensive Africa Agriculture Development Programme (CAADP) of the New Partnership for Africa's Development (NEPAD) have committed to achieving agriculture-led growth and development with an annual 6 percent growth in agriculture. Although the agricultural sector has grown more rapidly than the nonagricultural sector in recent years in some countries, growth in agriculture remains erratic over the longer term. The level of technology adoption in agriculture remains low and is considered one of the main constraints hindering a steady growth in food production systems in Africa (FAO and UNIDO 2008). Human labor still dominates as a source of power for African agriculture. Bisho-Sambrook (2005, 87) reports, for example, that in SSA 65 percent of farm power is human, 25 percent animal, and only 10 percent mechanical; in the other three developing regions—Asia, Near East and North Africa, and Latin America and the Caribbean—50 percent of farm power is from mechanical traction, with 25 percent each derived from human and animal labor (FAO and UNIDO 2008).

In Ghana, the government has had a checkered history of mechanizing agriculture.[1] The first attempt at mechanizing agriculture was made in 1938 when the use of animal draft power was introduced in the Northern Territories of the then Gold Coast for cultivation of groundnuts and cereals. This attempt was followed by a number of subsequent efforts to mechanize Ghanaian agriculture, including the introduction of tractors under the Gonja Development Project in the late 1940s and early 1950s. After independence, the new government, in a bid to produce food and fiber for the increasing population and the nation's infant industries, engaged in a bold plan of importing into the country a large number of agricultural tractors and related implements. The government's policy on agricultural mechanization was part of its first seven-year development plan (1963–1969). The objective of the plan was to increase the cash incomes of farmers and meet the high demand for food and fiber in the economy by getting away from the traditional cutlass and hoe, shifting the cultivation method of farming toward intensification and diversification of farm resources. The number of farming families was to be quickly reduced to one-quarter of the country's population within the plan period through the creation of large agricultural production units and through increased productivity (Twum and Gyarteng 1995). Unfortunately, this attempt did not yield results commensurate with the massive capital outlay. The Ministry of Agriculture and Transport Department continued to provide mechanization services until the early 1970s, when the government decided to disengage itself from mechanization efforts and leave them to the initiative of the private sector. However, to facilitate the development of a viable private sector, the government continued to provide support through development projects such as Block Farms Limited, the Upper Regional Agricultural Development Project (URADEP), the Volta Regional Agricultural Development Project (VORADEP), and so on (Twum and Gyarteng 1995). In 1986, under the IMF program of structural adjustment, the government withdrew from agricultural mechanization completely.

Currently, the mechanization strategy of the government involves establishing agricultural mechanization service centers (AMSECs) in each district where mechanization is possible. This strategy began in 2006. The AMSECs are to make machine service for farm activities available at farmers' doorsteps in each district that has potential for machine usage. The number of AMSECs has increased

[1] Until recently, agriculture has been one of the most important economic sectors in Ghana, employing more than half the population on a formal and informal basis and accounting for almost one-third of GDP and export earnings (GSS 2010). The country produces a variety of crops in various agroecological climatic zones, which range from dry savanna to wet forest and run in east–west bands across the country. Agricultural crops, including cassava, yams, grains, and cocoa, form the base of Ghana's economy.

from 12 centers at inception to about 85 centers as of 2009. The package involves the supply of 5 tractors with matching implements (plow, harrow, and trailer) at a highly subsidized price to a service provider. The service provider is required to pay a deposit of GHS 10,000, with the balance of GHS 70,000 payable in five years (AESD 2010).

The government of Ghana is making significant investments in the purchase of tractors with financing from its own funds as well as from donor funding sources. Because the budget of the Ministry of Food and Agriculture (MoFA) is small, a large portion of its investment expenditures is allocated to purchasing tractors. For example, in the Ministry's 2008 and 2009 budgets, GHS 1,199,101 and GHS 474,118 were budgeted to purchase 1,000 tractors and 500 power tillers respectively (Ghana, Ministry of Food and Agriculture 2008, 184–186). Meanwhile US$3.4 million was approved in 2007 for the purchase of KR2 tractors in 2008 (AESD 2008).[2] In the 2010 budget, the government allocates GHS 3,000,000 for agricultural mechanization, to be funded entirely by the government of Ghana, which constitutes 12.6 percent of total government funding for agricultural spending. This 12.6 percent represents nearly all the investment expenditures in the budget.

Objectives and Methodology

Conceptually, mechanization becomes economical when the labor required to carry out farming operations increases due to intensification to the point where either it exceeds labor supply or its cost exceeds that of mechanizing operations (Binswanger and Pingali 1988). The primary objective of this study is to examine the labor requirements associated with different cropping systems in Ghana in order to guide the prioritization of investments in mechanization in the country. First, major cropping systems are identified in the country by adopting the cropping pattern approach of Ruthenberg (1983), who defined farming systems according to the leading crop activities.[3] Second, labor requirements and costs of production of crops in the various systems are examined at various levels of substitution of either herbicides or animal and mechanical traction for labor. This study approaches the mechanization of agriculture broadly to include the use of herbicides as a substitute for labor, a practice adopted widely in several African countries. Nonselective herbicides are used to clear land after seeds are planted with minimum tillage. Selective herbicides are used for the control of weeds in standing crops.

The rest of the study is presented in five sections. Section 2 presents a review of the evolution of farming systems with reference to Ghana and to the cropping systems in Ghana identified on the basis of the cropping pattern approach. Section 3 presents the empirical aspects, labor requirements, and costs of production. Section 4 presents the labor requirements and production costs of different cropping systems. In Section 5, we examine the system wide and seasonal labor requirements in the country. Section 6 concludes with a summary and discussion of the policy implications of the study.

[2] The Kennedy Round 2 (KR2), now known as Grant Assistance for Underprivileged Farmers, is a grant facility designed to assist developing countries striving to achieve food sufficiency to carry out their food augmentation plans. The program's assistance comes in the form of grants-in-aid, which are used to procure farm inputs such as fertilizers, pesticides, farm machinery, and other agricultural equipment. The recipient country monetizes these farm inputs and the proceeds are used to finance agricultural projects.

[3] The leading crop activities are defined here as activities related to crops that occupied the largest areas cultivated on the farm.

2. CHANGES IN CROPPING INTENSITY AND CURRENT CROPPING SYSTEMS IN GHANA

Historically, farming systems evolve through five stages: gathering, forest fallow, bush fallow, short (or grass) fallow, and annual cultivation systems distinguished primarily by the degree of intensification (Boserup 1965). Intensification is the frequency with which a plot of land is cultivated, the level of application of inputs, or both (Boserup 1965; Pingali, Bigot, and Binswanger 1987; Ruthenberg 1983. The fallow period and the cropping period, which give an indication of the level of intensification in each stage of the farming system, are presented in Table 2.1. Following declines from as much as 20 years between cultivation to annual or permanent cultivation in this evolution.

Table 2.1—Cropping and fallow periods for the different farming systems

Farming system	Cropping period	Fallow period
Gathering	No cropping	
Forest fallow	1–3 years	20 years or more
Bush fallow	1–8 years	6–10 years
Short/grass fallow	Several years	1–2 years
Annual cropping	A few months	Less than 1 year

Source: Boserup 1965.

The evolution of farming systems from extensive to intensive is mainly determined by population density and the demand for agricultural commodities. When population increases or new markets open up to a rural community, the demand for food increases, which pushes the communities into producing more food through intensification. But in the final analysis, the responsiveness of a rural community to an increased demand for agricultural commodities depends on internal factors, such as available resources and household constraints, as well as external factors, such as transportation infrastructure, government policies, and political power dynamics of conflict (Dixon, Gulliver, and Gibbon 2001; Pingali, Bigot, and Binswanger 1987).

When farming intensifies beyond the bush fallow[4] stage, the transition from the hand hoe to mechanical equipment is believed to become profitable.[5] In fact, when farming intensity increases beyond the bush fallow stage, both the number and the intensity of field operations increase, making the labor required per unit of output and per unit of land high (Pingali, Bigot, and Binswanger 1987). For instance, the movement from forest fallow to annual cultivation in Liberia and Cameroon was associated with an increase in labor input per hectare of 770 hours and 3,300 hours, respectively (Ruthenberg 1983).

Although intensification may lead to mechanization, the order in which various tasks are mechanized depends on the nature of operations mechanized. Generally, power-intensive operations—those activities that require more power or energy, such as land preparation and threshing—are the first to be mechanized, before control-intensive activities, such as harvesting (Binswanger 1986, Binswanger and Pingali 1984, Pingali 2007). How much labor is required for various operations is also subject to local conditions, such as land endowment and wage levels. In addition to tractors, harvesters, and millers, farmers also use herbicides for land clearance (in zero tillage situations) and for weed control in standing crops.

[4] Bush fallow is a farming system in which plots are cultivated and then left fallow for a specific period prior to recultivation.

[5] In Ghana grassy savannas, however, where only a few tree stumps are present, it has been shown that the adoption of mechanized plowing may be cost effective as soon as in late bush fallow (Pingali, Bigot, and Binswanger 1987).

Farming Systems in Ghana

Farmers usually consider their farms, whether smallholdings or large corporations, as systems with complex structures of interrelationships between various components. Given differences in resource endowments and household characteristics, all farms are unique. Together, the household, its resources, and the resource flows and interactions at an individual farm level constitute a farm system. However, since factors such as biophysical, socioeconomic, and human capital conditions are exogenous, farms can be viewed as systems from different perspectives (Ruthenberg 1983; Dixon, Gulliver, and Gibbon 2001).

A farming system, by contrast, is defined as a population of individual farm systems that have broadly similar resource bases, enterprise patterns, household livelihoods, and constraints, and for which similar development strategies and interventions would be appropriate (Dixon, Gulliver, and Gibbon 2001). Indeed, no farm organizes its production exactly like any other, but farms producing under similar natural, economic, and socioinstitutional conditions tend to have similar structures. For the purpose of agricultural development and to formulate meaningful measures of specific agricultural policies such as adoption of mechanical equipment, farms with similar structural properties can be grouped into classes.

In Ghana, there are three dominant farming systems according to the intensity of cultivation: bush fallow systems (temporary systems), permanent systems, and combined systems. Bush fallow systems represent the most extensive farming systems in Ghana, while the permanent systems are the most intensive. The combined systems include bush fallow and short fallow. Under a relatively low population density up until the beginning of this century, the main system of farming in Ghana was forest fallow. In the northern part of the country, this involved the intercropping of the drought-resistant principal crops, millet (*Panicum miliaceum*) and guinea corn (*Sorghum guineense*), with yam (*Dioscorea dumetorum*), pulses, vegetables, and other crops; and in the South, intercropping of tree cash crops, such as cocoa and others. Over time, this farming system has transformed into a less extensive and more sedentary system known as the bush fallow system (Gyasi 1995).

The bush fallow system typically involves intercropping trees in outfields used on a rotational basis that are located 1–6 kilometers from the compound house. Bush fallow is characterized by the rotation of fields rather than of crops, easy acquisition of land for cultivation, use of fire for clearing vegetation, dependence on muscle power, and use of simple implements, such as dibble sticks, machetes, and hand hoes, for cultivation.

As population density increases, however, bush fallow systems become unsustainable, failing to produce enough food for the growing population. Boateng (1962) estimates 60 persons per square kilometer (150 persons per square mile) as being the sustainable population density for the bush fallow systems in Ghana (Figures 2.1 and 2.2). Population densities above this level decrease the period of fallow to a point that is detrimental to the soil. As population increases, cultivation moves from bush fallow to annual or permanent cultivation.

Figure 2.1—Major farming systems in Ghana, 1988

Source: Adapted from Dickson and Benneh 1988.
Note: The regions with highlight contour correspond to areas with low density but with permanent cultivation systems.

Figure 2.2—Population density in Ghana, 1988

Source: Constructed from 2000 census data (per square km).

Note: Although late bush fallow is still observed in the northern part of the country, interviews with farmers indicated that agriculture systems in Ghana are more and more transitioning to permanent systems.

There is a correspondence between population density and level of intensification in Ghana. In the southwestern part of the country, however, intensity of cultivation is higher than the population density would suggest. Even when population density is low, intensification may still occur when rural communities acquire access to new markets. In fact, in the semideciduous forest zone around Juabeso, as shown in Figures 2.1 and 2.2 above, cultivation is intensive despite low population density. This is mainly explained by the large global market for cocoa.

The permanent farming systems stretch across different agroecological zones in Ghana and are defined by rainfall patterns.[6] As noted by Dickson and Benneh (1988), temperatures in Ghana are high enough to permit plant growth in all parts of the country, but the amount of rainfall and its distribution is the major climatic factor that accounts for regional variation in plant growth. The tropical rainforest vegetation zone in the extreme southwestern part of the country receives more than 190 centimeters of rain annually. As rainfall decreases from south to north, the intensity of vegetation also decreases from moist, semideciduous forest to scattered trees and grassland. In the tropical rainforest vegetation zone,

[6] The agroecological zones in Ghana are rainforest, deciduous forest, transition zone, Guinea savanna, Sudan savanna, and coastal savanna.

permanent farming systems involve tree cash cropping, such as cocoa, and food cropping, such as cocoyam, plantain, and cassava. However, these systems take different forms of permanency.[7]

The combined system includes compound farming and distant farming. Compound farming involves intensive cultivation of the land immediately surrounding the compound house and is observed in the densely populated area of northeastern and northwestern Ghana. In addition to their compound fields, farmers cultivate lager fields at some distance away from the household, where they adopt the bush fallow system.

As farming moves from bush fallow to late bush fallow and permanent systems, when the costs of hand cultivation exceed the costs to transition to animal or tractor power, farmers may be expected to make the transition. How soon the cost of hand cultivation exceeds the cost of transition to other sources of power depends on factors such as type of soil or terrain and power intensity of the field operation to be mechanized.

In relation to the type of soil and terrain, the heavier the soil the greater the advantage of the animal-drawn and mechanical technologies. However, mechanization may be more difficult on mountain slopes. In relation to field operations, power-intensive operations are in general mechanized first. Control-intensive operations are generally mechanized later, especially when wages become high.[8] These depend, however, on the availability of land as well the wage rate (Herdt 1983; Pingali, Bigot, and Binswanger 1987).

This study adopts the leading crops approach to examining labor requirements, whereby farming systems are defined according to the leading crop activities of the holdings within ecological and vegetation zones (Ruthenberg 1983). It groups farms into "regional farming enterprises," defined according to farms' similarities in how they generate incomes. For example, a cocoa–maize–plantain enterprise would constitute a "regional farming enterprise" different from a maize–cassava–sweet potato enterprise.

In Ghana, zonal differences in cropping patterns are clearly recognizable. In the forest zones, food crops such as maize, plantain, and cassava are cultivated alongside cocoa, the predominant cash crop in the country. Around the urban areas of Accra, in the coastal scrub and grassland of the coastal savanna, lies a vegetable belt where cultivation of vegetables such as pepper, okra, tomato, and watermelon is predominant. Alongside these vegetables, other food crops such as maize and cassava are cultivated, and in recent years, this area has also seen the development of commercial mango plantations. In the Volta basin, which stretches through the forest, transitional, and savanna zones, cultivation of yam, rice, maize, and cassava predominate, but other crops such as sorghum, cowpea, and groundnut are also cultivated. Further north, in the savanna zones, where there is only one rainy season, the grain crops millet and sorghum are the major staples; however, other crops, including maize, groundnuts, cowpea, cassava, and sweet potato, are cultivated as well.

Different cropping patterns in different zones will have dissimilar implications in terms of both cropping practices and labor requirements. In fact, as noted by Ruthenberg (1983), as much as different crops cultivated at the same time on a given plot of land (intercropping) are interrelated by competition

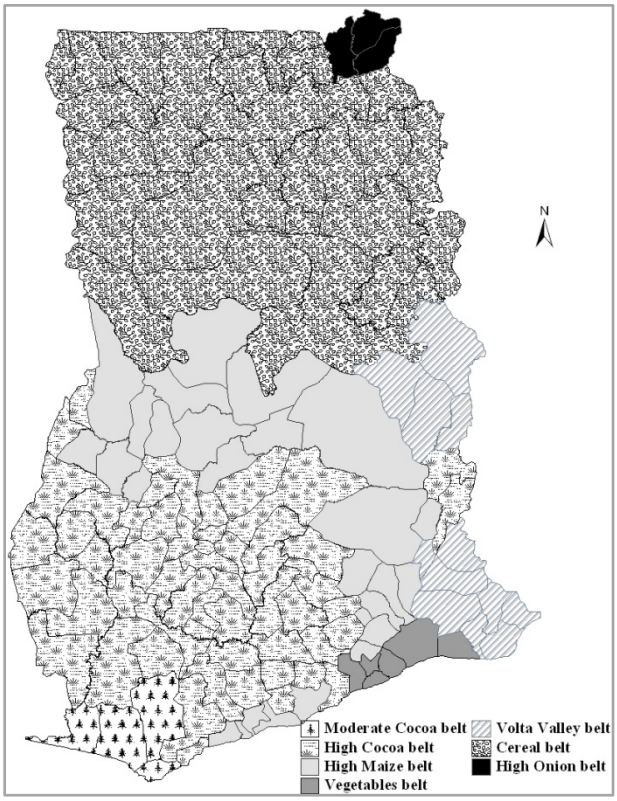
[7] Permanent farming takes the form of mixed farming, where both annual crop cultivation and pastoral farming are carried out. This system is more prevalent in the extreme northeastern part of the savanna climatic and vegetation zones than elsewhere. The most important factor explaining the practice of mixed farming in the savanna zones is the availability of grassland or fodder for feeding livestock. In the savanna, the continuous slash and burn enhances grassland vegetation, encouraging animal rearing alongside crop cultivation. Mixed farming is also encouraged by the absence of thick vegetation that harbors tsetse fly, which causes trypanosomiasis, the deadly cattle disease known as sleeping sickness. Permanent systems can also consist of specialized horticulture systems. These often involve production of tree crops or ornamental trees or shrubs and are similar in physiognomy to plantations. In Ghana, these systems consist rather of an intensive vegetable production, as is the case of the annual shallot cultivation in the coastal savanna zone that lies in the strand and mangrove vegetation zone. Horticulture is practiced in areas where the soil is sandy and lacks nutrients and where rainfall is scant and irregular (Benneh 1971).

[8] Power-intensive operations are defined as those that require greater power or energy than judgment, the most common of which include land preparation (tilling and plowing), threshing, and milling. Control-intensive operations are defined as those that require greater judgment or use of the human mind, the most common of which include weeding; herbicide, insecticide, or fertilizer application; and harvesting of delicate crops such as fruits or vegetables.

for light, water, land, labor, and soil nutrients, crops grown on different plots but on a same field could be related to each other because they compete for land, labor, machinery, and water. In some cases, however, the relationship can be complementary. A field in the valley bottom of a catena, for instance, may supply fodder and employment at a time when these are not available from the upland. Similar relations hold between arable crops and permanent crops (Ruthenberg 1983).

Since crops cultivated in the same area often compete for different inputs, understanding cropping patterns and how they affect labor requirements in different systems in Ghana is important in determining appropriate agricultural development strategies, specifically interventions for agricultural mechanization. Everything else being equal, labor availability for a crop in a given area depends on the labor requirements of other crops cultivated in the same area. This implies that labor availability for maize, for example, in an area where maize is cultivated alongside cocoa is expected to be different from availability in another area, where maize is cultivated alongside sweet potato. Therefore, the implications for a maize mechanization strategy may differ. Labor requirements for crops also vary due to differences in practices across systems.

Figure2.3—Regional farming enterprises in Ghana, 2008



Source: Constructed by the authors from Statistical Research and Information Directorate (SIRD data on area cultivated (2008).

Figure 2.4—Farming systems in Ghana, 1988[9]

Source: Adapted from Dickson and Benneh (1988).

Seven major crop systems or "regional farming enterprises" that have a few dominant crops in common can be identified in Ghana (Table 2.2). These 7 crop systems are identified on the basis of area under cultivation of major crops in 2008 in the 138 districts of the country (as defined by the 2005 administrative delimitation). For each district, 5 or 6 crops or crop groups were identified as dominant in

[9] Figure 2.4. repeats Figure 2.1.

terms of proportions of planted area devoted to their cultivation in the district. Contiguous districts with at least 3 of the dominant crop or crop groups in common were identified as a cropping system (Figure 2.3). The proportion of the 10 administrative regions that fall into each of these 7 cropping systems is shown in Table 2.2. No more than 2 systems are observed in any region.

These 7 systems transcend regional administrative boundaries and agroecological zones. In the forest zones of the southwest, where cocoa is cultivated alongside other food crops, two major systems were identified: high cocoa and moderate cocoa. In both systems, the cultivation of cocoa is combined with a similar set of other food crops, except that rice is more commonly grown in the moderate system. In the high cocoa belt, an average farmer cultivates cocoa alongside maize, cocoyam, plantain, and cassava. In the moderate cocoa belt, most prevalent in the tropical forest vegetation zone, a typical farmer cultivates cocoa together with rice, maize, plantain, and cassava.

In the coastal scrub and the coastal savanna in the southeastern part of the country lies the vegetable system, which stretches through the coastal scrub and grassland surrounding Accra. The average farmer in this belt cultivates vegetables such as pepper, tomato, garden egg, cucumber, cabbage, lettuce, watermelon, and okra, often combined with maize, cassava, and mango as cash crops. The high maize system is mostly observed in the derived savanna or forest called the transitional zone in the Brong Ahafo region, where maize yields are the highest obtained in the country. In this system, farmers cultivate maize with other food crops such as cassava, yam, cocoyam, and plantain.

The Volta valley system is mostly located in the areas surrounding Lake Volta, including the Volta region and part of the Eastern and Northern regions. The southern part of these areas has a bimodal rainfall distribution pattern while in the northern part it is unimodal. Hence, the south tends to have two farming seasons while the north has one major season. The vegetation of the area is partly semideciduous forest and partly coastal scrub and grassland. The different vegetation found in the areas surrounding Lake Volta permits the cultivation of certain crops that are specific to the northern and southern parts of the country. Crops such as rice, maize, cassava, yam, cocoyam, and sorghum are predominant in the Volta valley. Other vegetables, such as shallot and okra, are also cultivated there.

Further north, two distinct systems were identified: the cereals and the high onion systems. Both systems are located in areas where the rainfall distribution pattern is unimodal and where the dry season lasts from November until March. The cereals system covers the Northern and Upper West regions of the country. The average farmer in this system cultivates sorghum and millet as the major staple foods alongside other food crops such as soybean, cassava, groundnut, yam, maize, and cowpea. These crops are often combined with the cultivation of tree crops, such as cashew and shea nuts. Worth noting is that in the cereals system there is really not a clear crop pattern for the entire belt. There is a large number of microsystems that could be studied more specifically.

In the high onion system, on the other hand, the average farmer cultivates mainly onion, maize, sorghum, millet, sweet potato, and cowpea. Cash crops found in this system are onion, tomato, and soybean. Tomato and onion are cultivated exclusively in the dry season.

Table 2.2—Regions falling into the seven systems (in percentages), 2008

System	Leading crops	Ashanti	Brong Ahafo	Central	Eastern	Greater Accra	Northern	Upper East	Upper West	Volta	Western
Moderate cocoa	Cocoa, rice, maize, plantain, cassava										31
High cocoa	Cocoa, maize, cocoyam, plantain, cassava	95	37	62	53					13	69
High maize	Maize, cassava, yam, cocoyam, plantain	5	63	38	47						
Vegetable	Tomato, pepper, okra, watermelon, maize–cassava					100					
Volta valley	Rice, maize, cassava, yam, cocoyam									87	
Cereals	Yam, sorghum, millet, soybean, cassava, groundnut–maize–cowpea						100	63	100		
High onion	Sorghum, millet, onion, sweetpotato, cowpea, maize							38			
Total		100	100	100	100	100	100	100	100	100	100

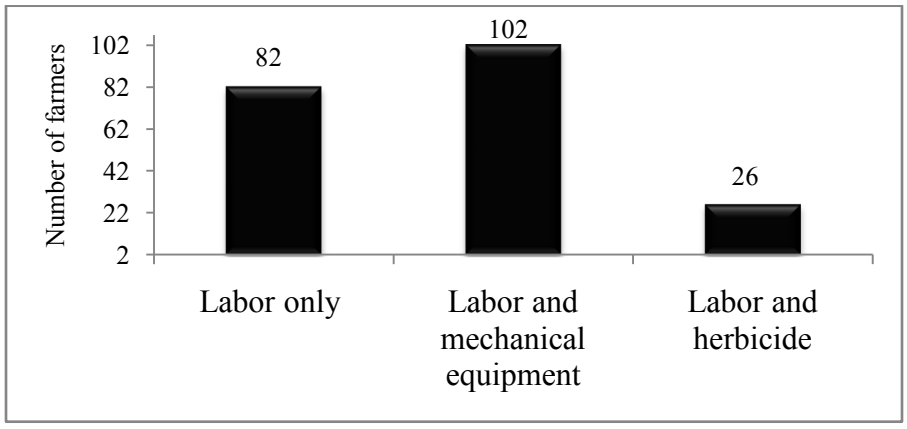
Source: Authors' calculation from data from Ghana, MoFA on area cultivated by crops.

3. EMPIRICAL ASPECTS, LABOR REQUIREMENTS, AND COSTS OF PRODUCTION

One district in each system was selected for our examination of labor requirements: Nzema East (moderate cocoa), Juaboso (high cocoa), Dangme East (vegetable), Kintampo North (high maize), Nkwanta (Volta valley), Yendi (cereals), and Bawku Municipal (high onion). Three communities were visited in each district, and in each community 10 farmers were interviewed with the assistance of the district agriculture development units (DADUs). In all, 210 farmers were interviewed using a structured questionnaire. The second round of data collection involved focus group discussions in the survey communities, where the results from the interviews were discussed to validate them.

Three categories of farmers were interviewed: farmers using only labor for all their farming activities, farmers combining labor with mechanical traction, and farmers combining labor and herbicide use. More than half of the farmers interviewed had mechanized some of the functions on their farms (Figure 3.1). Where mechanical traction was used, it was primarily for land preparation. Herbicides were used primarily for weeding and, to a more limited extent, for land clearance (zero tillage).

Figure 3.1—Number of farmers that used different farm technologies



Source: Constructed by the authors from own 2009 survey data.

Among the 102 farmers that used mechanical traction along with labor for farming, 77 used tractors while the remaining 25 used animal drafting. The 25 farmers who used animal drafting were all found in the high onion system. None of the farmers interviewed in the moderate cocoa and high cocoa systems used tractors. The 82 farmers using only labor were represented in all systems. Herbicides were used for weed control in all systems except the vegetable system.

Agriculture is predominantly smallholder-based in Ghana. About 90 percent of farm holdings are less than 2 hectares in size, although there are some large farms and plantations, particularly for rubber, oil palm, and coconut, and to a lesser extent rice, maize, and pineapples (Ghana, Ministry of Food and Agriculture 2007). The average farm size for our sample was 3.7 acres (1.5 hectares) with minimum and maximum acreage of 0.25 and 40 acres, respectively (Table 3.1).

Table 3.1—Average, minimum, and maximum farm size across belts (in acres)

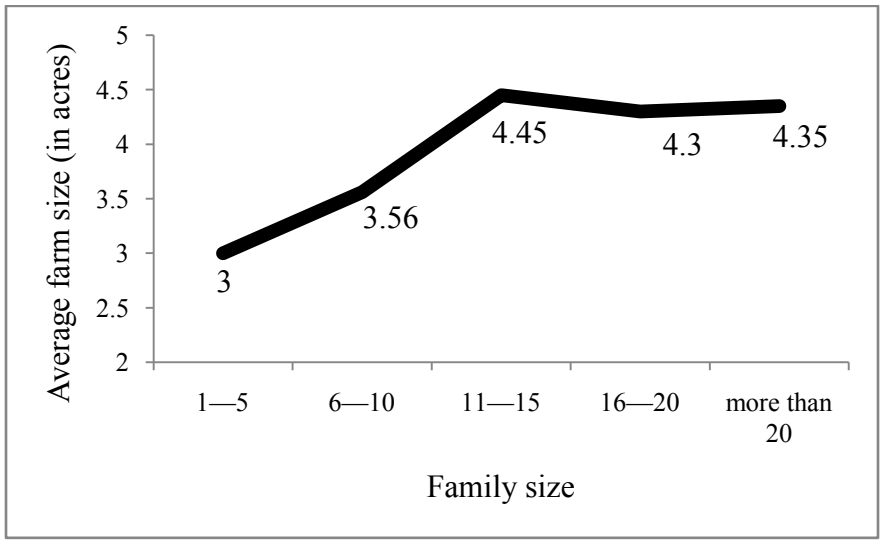
	High onion	Vegetable	High cocoa	High maize	Volta valley	Moderate cocoa	Cereals
Average size	2.4	4.5	3.5	3.4	5.9	1.5	4
Min. size	0.5	0.5	1	0.5	0.5	0.25	1
Max. size	10	40	15	10	35	7	20

Source: Constructed by authors from own 2009 survey data.

On average, the farmers in the Volta valley system had the largest farms, at about 6 acres. The relatively large farms in this system could be due to the presence of a large number of commercial farmers.

Although this was not a representative sample, some interesting relationships can be observed. Farm size was related to the family size of the farmers interviewed. Family size here is defined as the number of people sharing meals on a regular basis in a household. So a family may consist of a nuclear family or an extended family with people of all ages. Farm size increased with family size (Figure 3.2).

Figure 3.2—Relationship between farm size and family size



Source: Constructed by authors from own 2009 survey data.

Farm size increased from 3 acres to 4.45 acres as the family size increased from 1–5 members to 11–15 members, and remained almost unchanged with further increases in family size. Interestingly, the larger farms, which tended to have larger households, also tended to substitute mechanical traction and herbicides for labor (see Figure 3.3).

Figure 3.3—Farm size and labor substitution

Source: Constructed by authors from own 2009 survey data.

Labor is an important factor of production for farming in Ghana. Historically, smallholders have used only family labor for their farming. "Family labor" consists of family members, friends, and community members who are not paid for the work but paid in kind in the form of food and drink or part of the harvested output. The communal labor exchange system, called *nnoboa* in the Twi language, is an arrangement whereby groups of farmers in an area pool their labor, taking turns working in different members' fields.

Nearly 90 percent of Ghanaian farmers hire labor. In general, laborers are paid either a daily wage or on a piece basis. Activities such as land preparation, which includes clearing, cutting of trees, destumping, and burning, are contracted out with a per-acre payment. For harvesting legumes in particular, the labor is paid for as a share of the crop harvested. Laborers are also given food. There is also the in-kind form of hired labor even though this is not as popular as the first two forms.

The daily wage (commonly called "by-day" in Ghana) is uniform within communities for weeding but varies for other less tedious jobs like sowing and watering. The charges for performing particular tasks are often pegged to what it may cost to adopt a different technology. For example, the charges for manually clearing a field for planting are often tied to per-acre charges for plowing.

Daily wages and per-acre costs of contracting out farm operations vary significantly. They are usually higher in areas where permanent farming is practiced. The daily wage per person for weeding in our sample was GHS 5 in the moderate cocoa, high cocoa, and high maize belts, and GHS 3 and GHS 2 for the Volta valley and the two savanna belts (cereals and high onion), respectively (see Table 3.2). For the vegetable belt, laborers for clearing during land preparation are usually hired on a contract basis, and the amount paid to them is often aligned to the cost of using a tractor for plowing during land preparation, which ranged from GHS 20 to GHS 25 during the season. The contract wage for the moderate cocoa and high cocoa belts was GHS 40 due to the presence of cocoa and the inability to use tractors, resulting in a high demand for labor. In the next section we discuss labor requirements for field operations as they relate to cropping practices in different regional enterprises in Ghana.

Table 3.2—Wages for weeding in different belts (per acre)

	Daily wage	Contract cost (per acre)	
Belt	**GHS**	**Minimum (GHS)**	**Maximum (GHS)**
Moderate cocoa	5	40	40
High cocoa	5	40	40
High maize	5	25	30
Vegetable	-	20	25
Volta valley	3	25	30
Cereals	2	25	30
High onion	2	20	25

Source: Constructed by authors from own 2009 survey data.

4. LABOR REQUIREMENTS OF VARIOUS CROPPING SYSTEMS IN GHANA

Cultivation involves a sequence of field operations performed throughout the season. These operations can be classified into four broad categories: land preparation, sowing, crop maintenance, and harvesting. Land preparation includes clearing, destumping, plowing, and mounding. Crop maintenance includes any intercultivation, fertilizer application, insecticide application, and weeding. Harvesting includes uprooting, transporting, shelling, dehusking, and other activities that take place from the time the crops mature until they are sold.

Both landownership and cultivation practices of farmers influence labor requirements. Farmers who own their farmlands have a higher probability of hiring labor than those who sharecrop. While field operations in all belts involve land preparation, tasks performed in sowing, crop maintenance, and harvesting vary considerably from one system to the other. Land preparation consists generally of one or more clearing tasks (weeding, felling of trees, burning, destumping, and gathering of debris), plowing, and in some cases mounding and ridging, but not all these tasks are carried out in all the systems. Clearing virgin forests may require more labor for land preparation than preparing lands in secondary forests. Depending on the number of tasks performed in different systems, labor required for land preparation would be different. In both cocoa systems, for example, land preparation requires more labor than in other systems because of existing vegetation. There are differences in land preparation costs for rice between the two systems due to differences in how the lands are prepared.

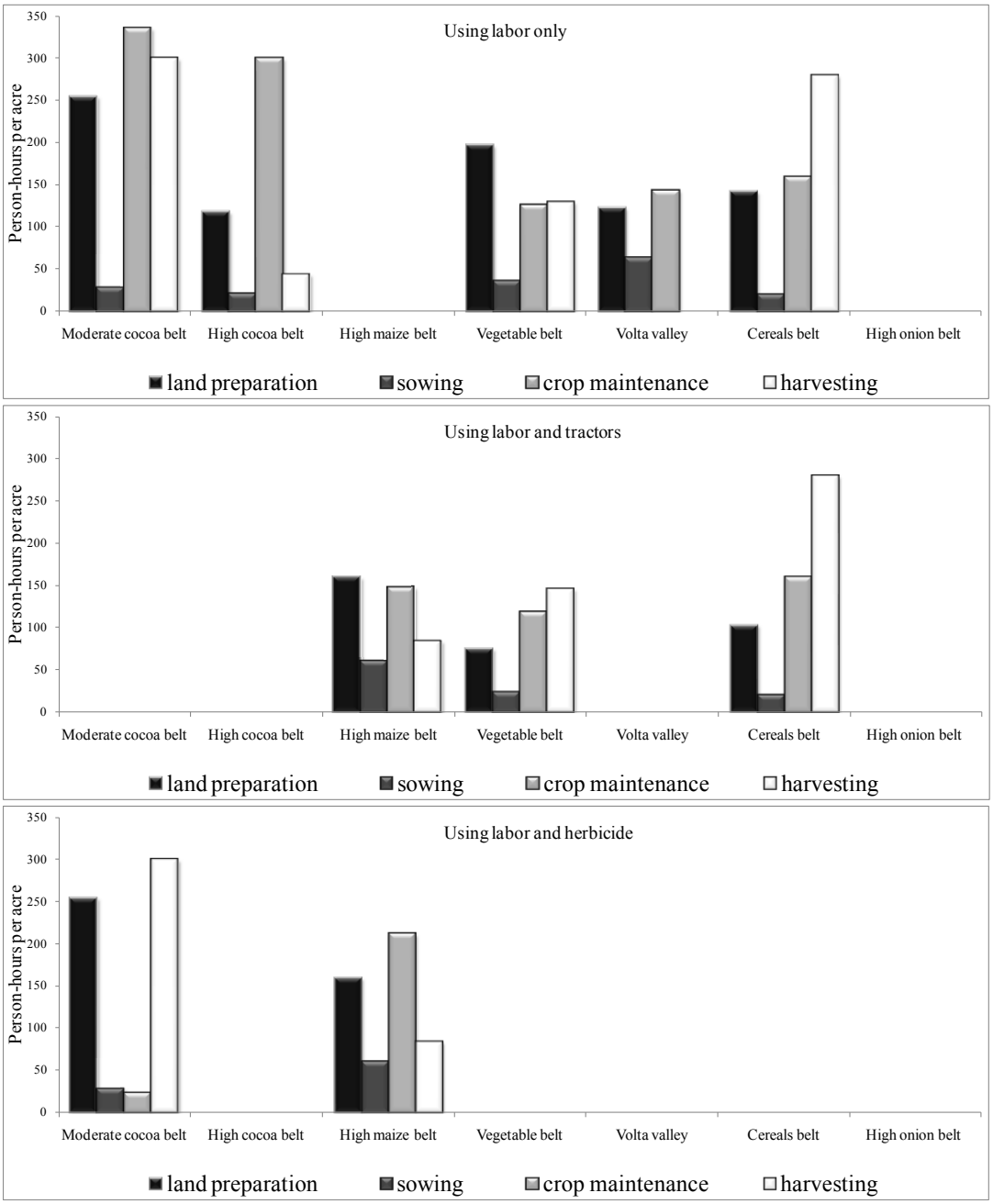
Sowing may range from simple broadcasting of rice seeds to dibbling and planting of seed. In the moderate and high cocoa, vegetable, Volta valley (southern part), and high onion systems, the dibbling and dropping of seeds are done by the same individual. In the cereals system, sowing is done by two people, with one dibbling and the other sowing the seeds. Fertilizer application, too, varies in technique: In Volta valley, for example, it may require more labor than in other areas because of the practice of dibbling fertilizers. We find no labor use in harvesting cassava in high cocoa and Volta valley because cassava is sold as a standing crop.

Labor Requirements for Major Food Crops with Various Levels of Substitution

Labor Requirements for Cassava

Cassava, the most favored tuber in Ghana, with a per capita consumption of 148 kilograms per year, is cultivated in all but the high onion system. Figure 4.1 shows that cassava cultivation required the most labor in the moderate cocoa system (919 person-hours per acre), followed by cereals (602), vegetable (489), high cocoa (483), and Volta valley (331). Crop maintenance and harvesting are the two labor-demanding operations for most of the systems, except that the requirements for land preparation are particularly high in the moderate cocoa system. Harvesting labor was reported to be low in the high cocoa system because farmers usually sell standing crops and the buyers are responsible for harvesting. On the other hand, labor used for harvesting is high in the cereals system, possibly because of the use of communal labor.

Figure 4.1—Labor requirements for cassava across systems



Source: Constructed by authors from own 2009 survey data.

Tractors are not used in the high and moderate cocoa systems in the forest zones because of the presence of bush vegetation and dense, thick trees.[10] They are used for cultivation of cassava in other systems. The use of tractors reduced the labor requirement for land preparation by 62 percent and 37 percent in the vegetable and the cereals systems, respectively. As a result, the costs of land preparation per acre in the vegetable and cereals systems decreased from GHS 80 to GHS 53 and from GHS 78 to

[10] Only 14 serviceable tractors were recorded in the Western region in 2008, representing the lowest number in the country; the highest was 609, in the Northern region (AESD 2008).

GHS 68, respectively. It can be observed, however, that there was a slight increase in the labor requirement for harvesting because average yields per acre are higher where tractors are used for field preparation.

Herbicides are used to clear the land for planting (with zero tillage) in the high maize system and for controlling weeds in standing crops of cassava in the moderate cocoa system. In the high maize system, tractor and herbicide use reduced labor requirements to a similar extent, but the cost of using herbicide is about 24 percent lower than that of using tractors. In the moderate cocoa system, herbicide used for weeding reduced the labor demanded for crop maintenance by 92 percent and resulted in a cost reduction from GHS 240 to GHS 132. Worth noting is that the labor requirement for crop maintenance was slightly higher when zero tillage was used than when a tractor was used. This could be because tillage often significantly helps control weeds (Pingali, Bigot, and Binswanger 1987).

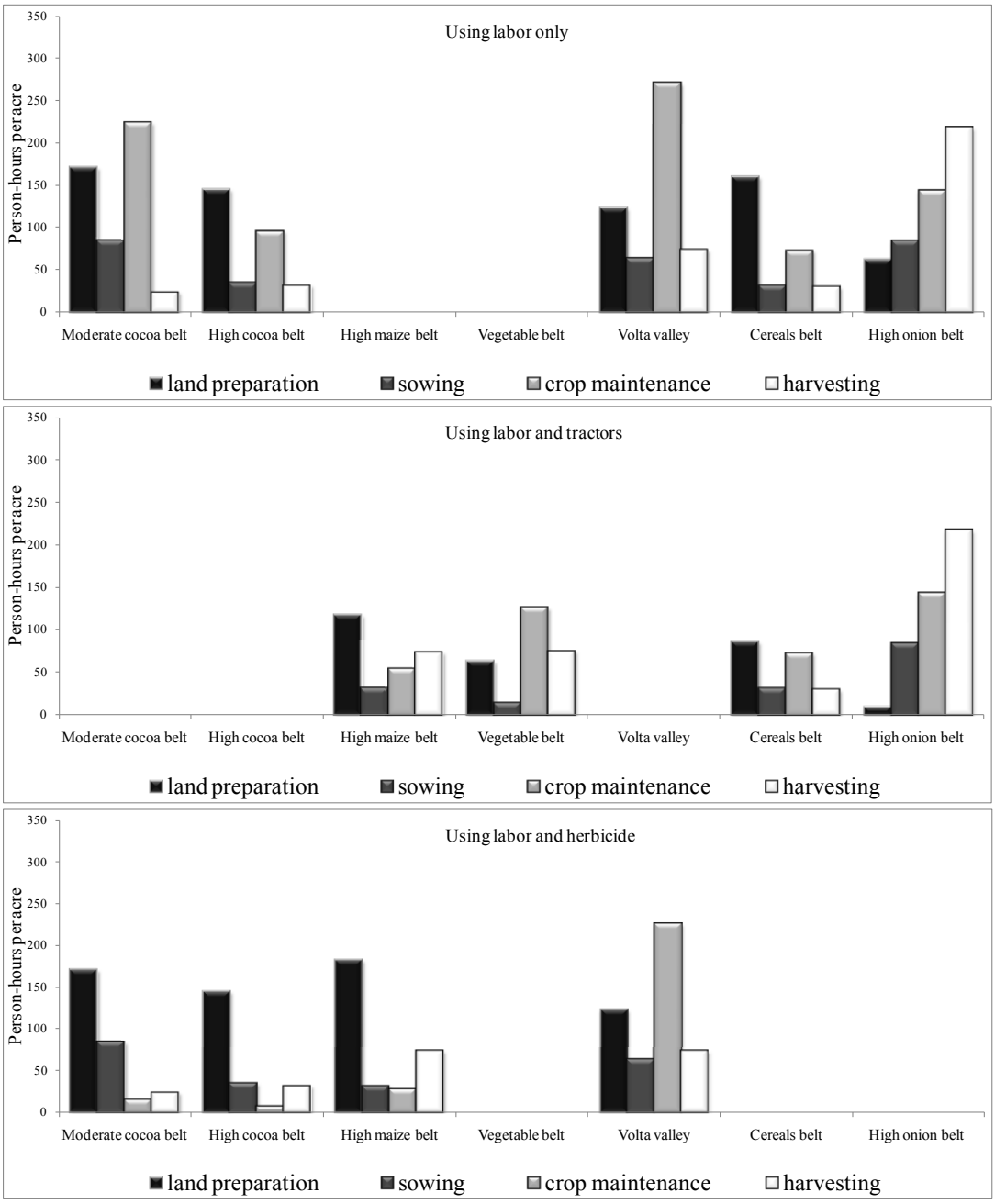
Labor Requirements for Maize

Maize is the most favored cereal in Ghana, with per capita consumption of 48 kilograms per year. Maize was found in all systems identified in this study, but with large variation in terms of yield across systems. The highest yields of maize were observed in the high maize system, located in the central part of the country, particularly in the transitional agroecological zone.

Overall, maize demands less labor for cultivation than does cassava (see Figure 4.2). The total labor requirements for maize were greatest in the Volta valley system (531 person-hours per acre), followed by high onion (507), moderate cocoa (503), high cocoa (308), and cereals (295). By way of comparison, labor requirements for maize were 45 percent of those for cassava in the moderate cocoa belt, 36 percent in high cocoa, and 50 percent in cereals. This is mainly explained by differences in labor requirements for land preparation and crop maintenance. Land preparation demands more labor for cassava because in most cases it requires the construction of mounds, while crop maintenance labor demand is high because cassava, as a yearlong crop, requires more weeding. However, in the Volta valley system, the labor requirement for maize was 38 percent higher than for cassava because cassava is planted in this system without construction of mounds. Mechanical traction is used in all maize-growing systems outside the forest zone. In the cereals system, the use of a tractor reduced labor use in land preparation by 46 percent, entailing a cost reduction from GHS 60 to GHS 22 to prepare an acre of land. In the high onion system, the use of animal traction reduced labor use for land preparation by 83 percent. However, little change was observed in terms of money savings when animal traction was used.

Herbicide is used, mainly to combat weeds, in the two cocoa systems in the forest zone and in the high maize and Volta valley systems. In the moderate and high cocoa systems, herbicide use reduced labor requirements by 93 and 91 percent, respectively. However, only in the moderate cocoa system did the decrease in labor use result in considerable savings to farmers, reducing the cost of crop maintenance from GHS 160 to GHS 88; in the high cocoa system, on the other hand, herbicide reduced crop maintenance costs by only 0.4 percent. This is explained by the high price of herbicide in this belt. In the Volta valley, use of herbicide had only a moderate effect on both labor use and its associated cost. This seems to be the case because most labor used for crop maintenance is for fertilizer application rather than weeding.

Figure 4.2—Labor requirements for maize across systems



Source: Constructed by authors from own 2009 survey data.

Labor Requirements for Rice

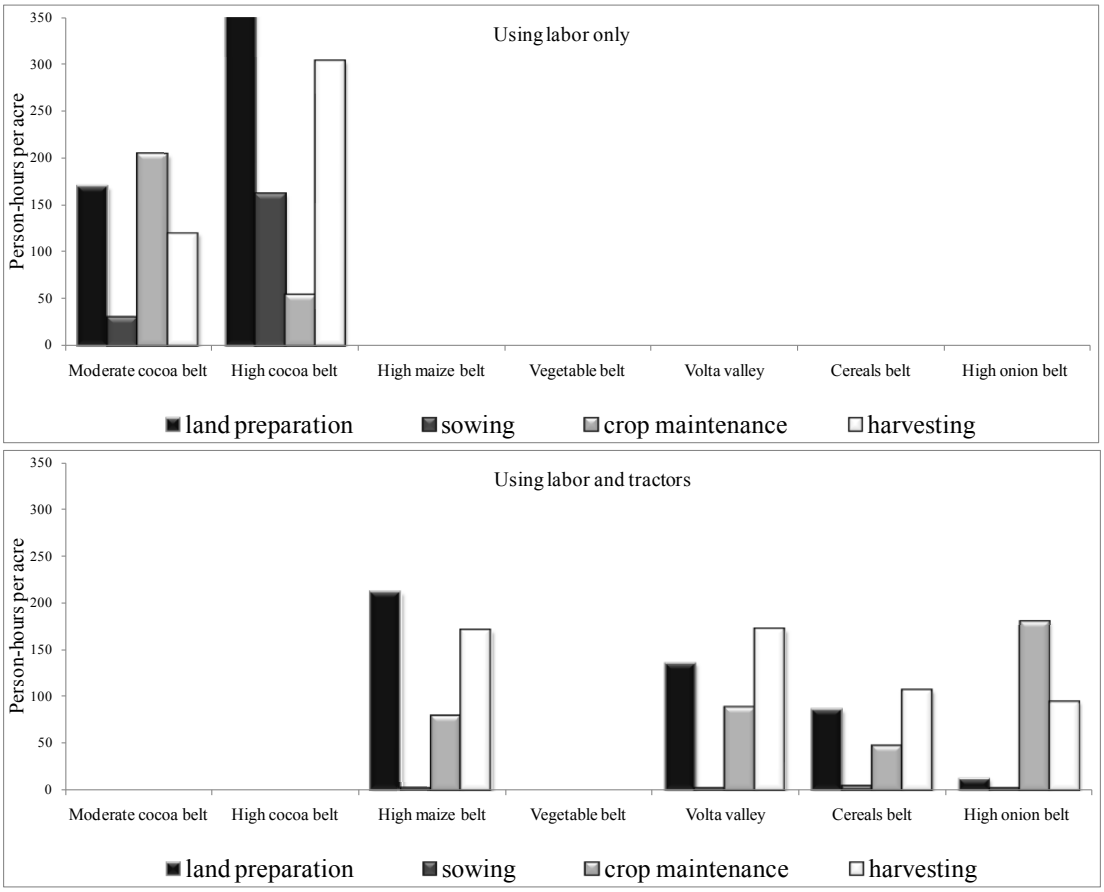
Rice is the second most favored cereal in Ghana, with per capita consumption of 15.1 kilograms per year. In most cases, as shown in Figure 4.3, rice requires more labor to cultivate than maize but less than cassava. This appears to be the case because cassava is a yearlong-growing crop, while maize grows over six months and requires less weeding (most farmers reported only one weeding during the growing season). Rice is cultivated in the forest zone using only labor, and the labor requirement tended to be higher in the high cocoa system (910 person hours per acre) than in the moderate cocoa system (523.3 person hours per acre). This is because in the high cocoa system, land preparation for rice cultivation is

more systematic and includes ridging. In the moderate cocoa system, on the other hand, farmers broadcast immediately after plowing. So in the high cocoa belt, cultivation of rice tends to be more intensive than in the moderate cocoa belt.[11]

Tractors are used in all other systems except the vegetable system, where cultivation of rice is not significant.[12] Labor requirements for land preparation using tractors were 212, 136, and 86 person-hours per acre in the high maize, Volta valley, and cereals systems, respectively. In high onion, where animal traction is used, labor requirements for land preparation were 12 person-hours per acre. Worth noticing is that in recent years an effort is being made to mechanize other operations in rice cultivation, including threshing.

Herbicides are used for weeding in standing crops in the moderate cocoa, Volta valley, and cereals belts. In the moderate cocoa system, it reduced labor demand by 88 percent, entailing a reduction of cost from GHS 65 to GHS 50.

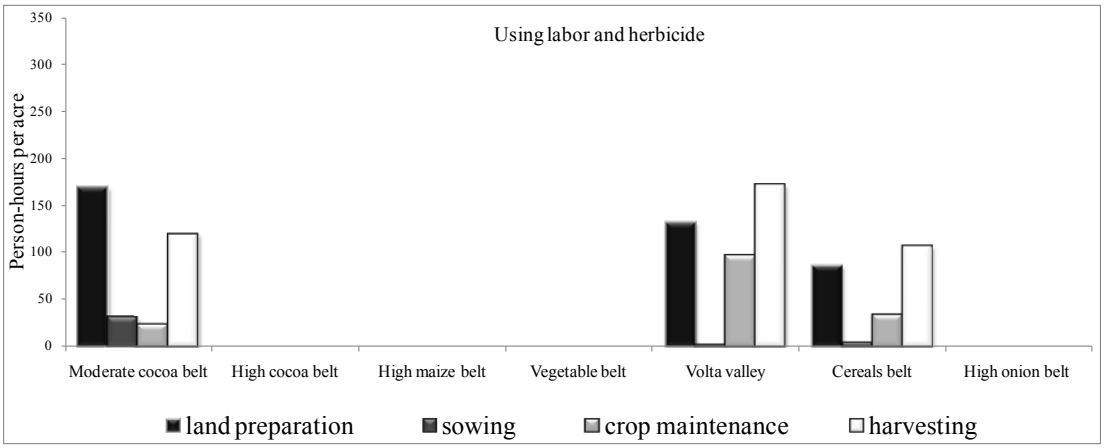
Figure 4.3—Labor requirements for rice across systems



[11] Experience in other countries has shown a similar pattern. Movement from extensive to more intensive rice cultivation was associated with increases in person-hours per acre amounting to 169, 122, and 289, respectively, in Liberia, Côte d'Ivoire, and Cameroon (Ruthenberg 1983).

[12] New projects of rice cultivation are developing in Dangme West.

Figure 4.3—Continued



Source: Constructed by authors from own 2009 survey data.

Labor Requirements for Yam

Yam is the second most favored root crop after cassava in Ghana, with per capita consumption of 41.9 kilograms per year. It is cultivated mainly in the Volta valley, cereals, and high maize systems. The cultivation of yam in most cases demands more labor than maize and rice, but less than cassava. Total labor required for yam cultivation is 670 person-hours per acre in high maize, 477 in cereals, and 474 in Volta valley, costing GHS 419, GHS 233, and GHS 205, respectively (see Figure 4.4). Tractors are used only to a small extent in yam cultivation. This could be because of the difficulty in constructing mounds carefully with a tractor, as is required for yam. In the high maize system, for instance, mounding represented nearly 50 percent of labor required for land preparation for yam. Tractor use in yam cultivation was observed only in the cereals system, where use of tractors reduced labor required for land preparation by about 60 percent, leading to a 20 percent reduction in costs (from GHS 108 to GHS 86).

Figure 4.4—Labor requirements for yam across systems

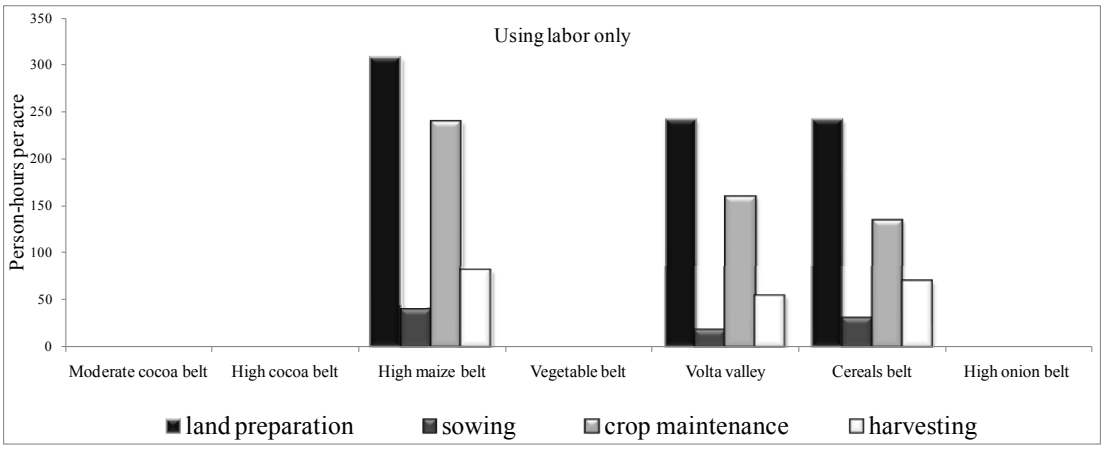
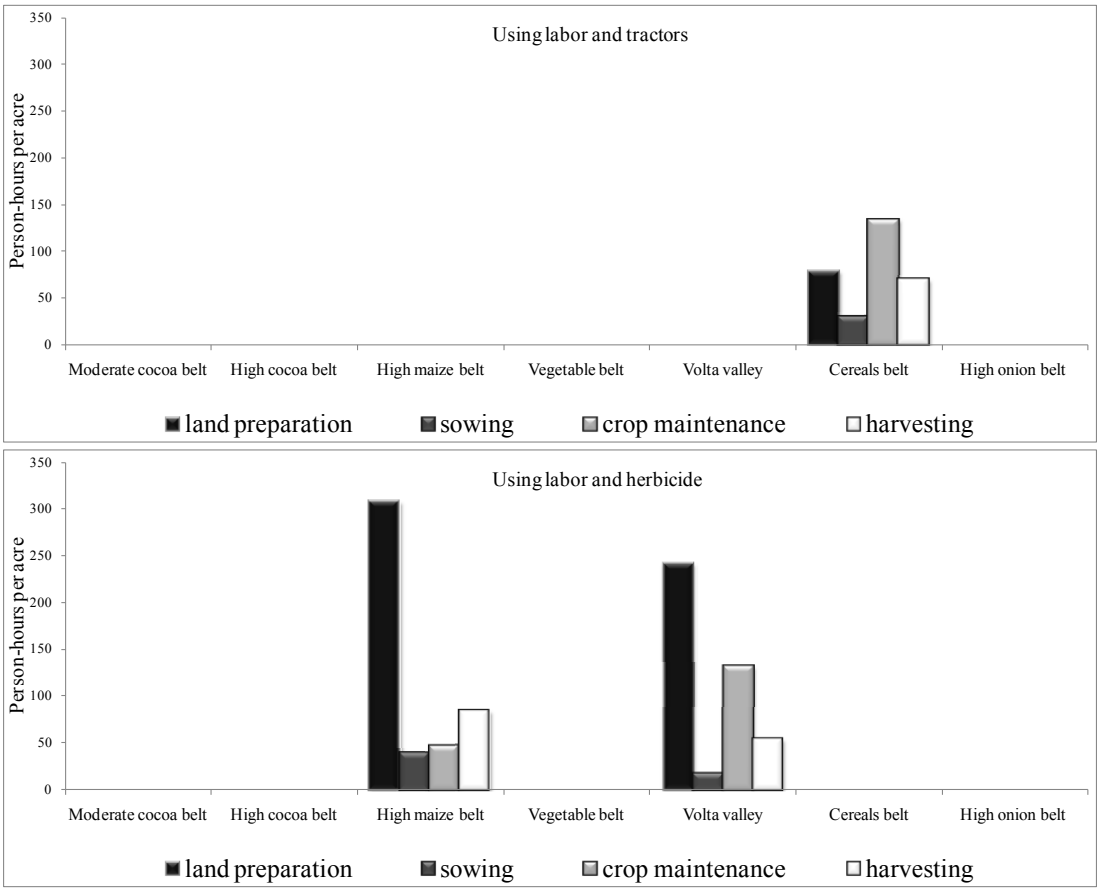


Figure 4.4—Continued



Source: Constructed by authors from own 2009 survey data.

Yam growers in the Volta valley and high maize systems use herbicide during the growing season for weed control. In both belts herbicide use was associated with a significant reduction in person-hours used for crop maintenance: 18 percent in Volta valley and 80 percent high maize. In terms of cost, there was a reduction from GHS 419 to GHS 345 in the high maize belt and from GHS 206 to GHS 194 in the Volta valley.

In sum, labor requirements of crops vary across systems because of differences in land conditions and cultivation practices, and the savings from substituting mechanical traction or herbicides for labor in land clearance or weed control also vary. In the moderate cocoa belt, for example, where natural vegetation includes bush or trees, we observed a high labor requirement for clearing, cutting trees, and destumping during land preparation, and for weeding, pest control, and soil improvement for crop maintenance during the growing season. In some cases, however, where markets have adjusted and labor costs are determined on the basis of mechanization costs, there are no clear benefits to switching from one to the other because the differences in cost are marginal (see Tables 4.1-4.4).

Table 4.1—Labor cost of cultivating an acre of cassava by system and technology

Technology/system	Moderate cocoa	High cocoa	High maize	Vegetable	Volta valley	Cereals	High onion
Labor only	682	408	-	215	240.4	293	-
Labor & mechanization	-	-	490	187.5	-	283.00	-
Labor & herbicide	574	-	485	-	-	-	-

Source: Constructed by authors from own 2009 survey data.

Table 4.2—Labor cost of cultivating an acre of maize by system and technology

Technology/system	Moderate cocoa	High cocoa	High maize	Vegetable	Volta valley	Cereals	High onion
Labor only	430	331	-	-	344.9	109.5	174.5
Labor & mechanization	-	-	189	240.25	-	71.5	174.5
Labor & herbicide	358	321	212.00	-	322.9	-	-

Source: Constructed by authors from own 2009 survey data.

Table 4.3—Labor cost of cultivating an acre of rice by system and technology

Technology/system	Moderate cocoa	High cocoa	High maize	Vegetable	Volta valley	Cereals	High onion
Labor only	412.6	996	-	-		-	-
Labor & mechanization	-	-	273	-	290.5	325	301.0
Labor & herbicide	397.6	-	-	-	282.5	335	-

Source: Constructed by authors from own 2009 survey data.

Table 4.4—Labor cost of cultivating an acre of yam by system and technology

Technology/system	Moderate cocoa	High cocoa	High maize	Vegetable	Volta valley	Cereals	High onion
Labor only	-	-	419	-	206	233	-
Labor & mechanization	-	-	-	-	-	211	-
Labor & herbicide	-	-	344.5	-	194	-	-

Source: Constructed by authors from own 2009 survey data.

While these results indicate that mechanical inputs and herbicides have the potential of reducing labor demand for field operations for different crops, mechanization strategies are often conceived for the entire system rather than for an individual crop. It is therefore important to determine what the labor requirements for different systems are and how mechanization or herbicide application may affect them.

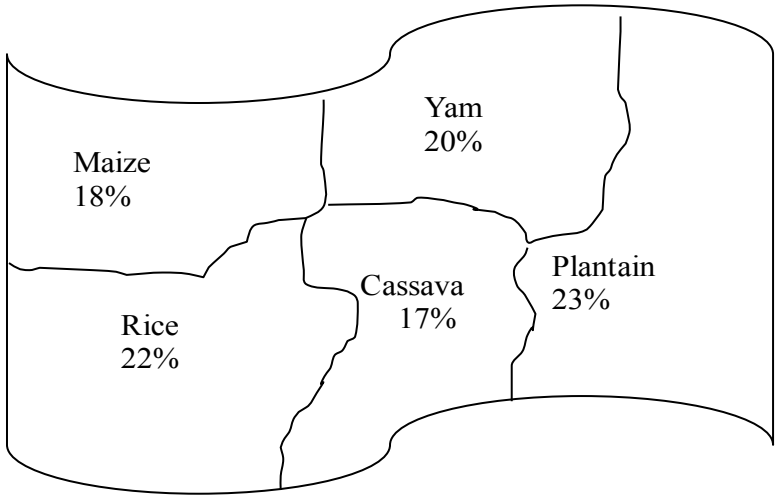
5. SYSTEMWIDE AND SEASONAL LABOR REQUIREMENTS

Labor Requirements across Systems in Ghana

The labor requirement (LR) for a system is defined here as the weighted average of the requirements of all the leading crops in that system. The weight for each crop is the relative area devoted to the cultivation of that crop (in percentage). So, in a region where area cultivated is distributed as shown in Figure 5.1, the system labor requirement is obtained as follows:

$$System_{LR} = \text{Maize}_{\text{LR}}\,18\% + \text{Yam}_{\text{LR}}\,20\% + \text{Rice}_{\text{LR}}\,22\% + \text{Cassava}_{\text{LR}}\,17\% + \text{Plantain}_{\text{LR}}\,23\% \quad (1)$$

Figure 5.1—Hypothetical distribution of area cultivated

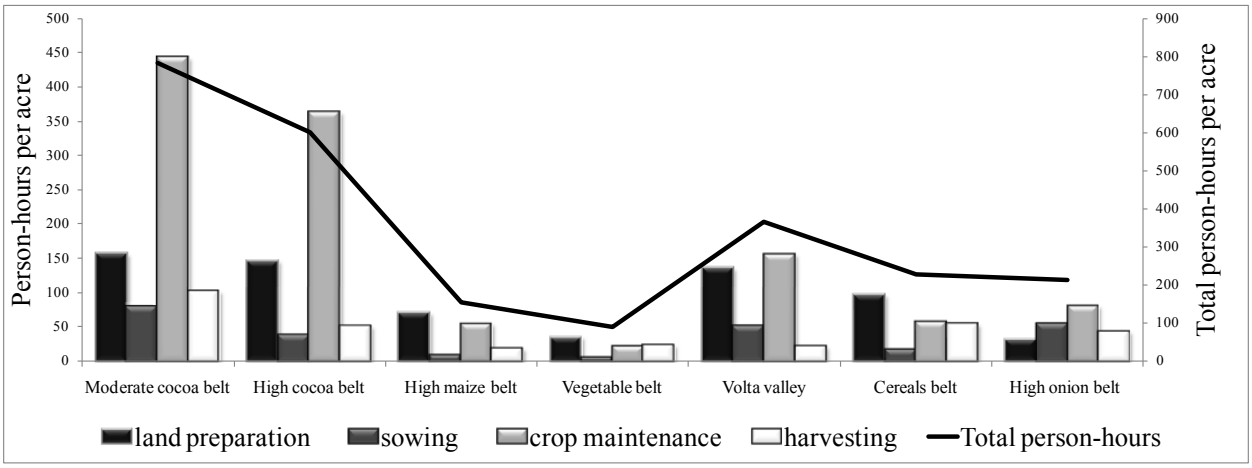


Source: Constructed by the authors.

In some of the cropping systems, the major or dominant crops account for the bulk of the total area planted, but in others they account for only a small portion of the cropped area. In the cereals and high onion systems, for example, the major crops accounted for only 36 percent of the cropped area in our survey. Hence, the foregoing analysis may underestimate the per-acre labor requirements in these systems. The labor requirements used in the analysis are without any substitution of either herbicides or mechanical traction for human labor. Among the seven systems, the moderate cocoa belt, with 783.28 person-hours per acre, had the highest labor requirements, followed by high cocoa (601), Volta valley (366.14), cereals (228.36), high onion (211.29), high maize (154.28), and vegetable (89.71). It is useful to note that the high labor requirements in the cocoa systems excluded the labor requirements of cocoa. In these two systems the highest requirements were for crop maintenance, followed by land preparation, harvesting, and sowing. Crop maintenance accounted for 61 percent of the total labor requirements in the high cocoa system and 57 percent in the moderate cocoa system. The lowest labor requirement was found in the vegetable belt.

The number of relevant crops used in the computation of labor requirements by system and the weights associated with each crop greatly impacted the total person-hours used in the system. Per-acre requirements of labor in the two cocoa belts were nearly three times the per-acre labor requirements in the other crop systems. As can be seen in Figure 5.2, the bulk of the labor required was for crop maintenance. Excluding the two cocoa belts, where plowing cannot be mechanized, land preparation requirements for labor were highest in Volta valley and the cereals belt. The requirements ranged from 100 to 150 person-hours per acre.

Figure 5.2—Labor requirements by system, using labor only



Source: Constructed by the authors from own 2009 survey data.

In conclusion, labor requirements were high in the crop systems of the forest zone. In all these belts, crop maintenance was the most important contributing factor, followed by land preparation.

Seasonal Labor Requirements in Ghana

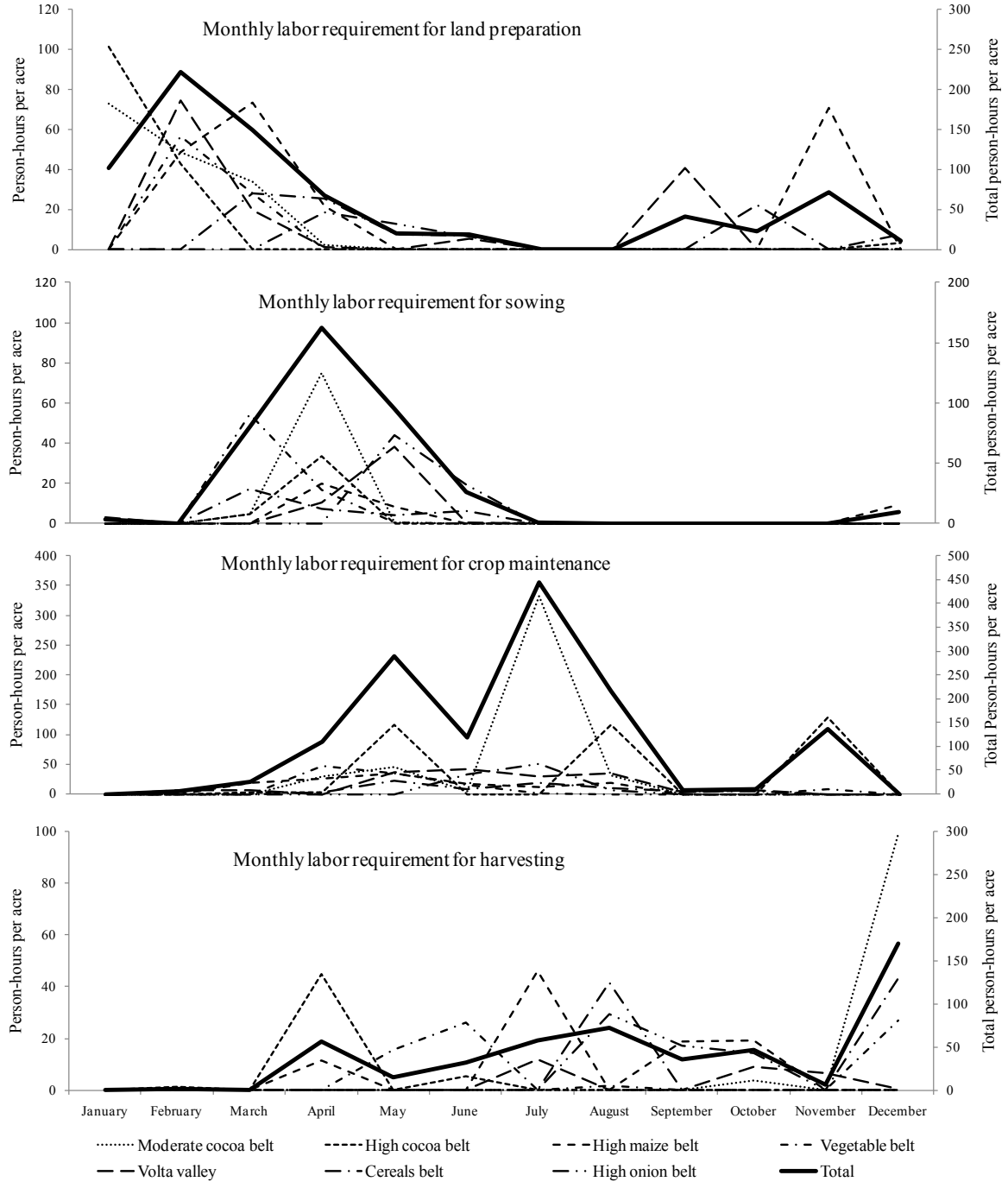
Agriculture in Ghana is mostly rainfed.[13] The country is divided into two main zones based on the rainfall pattern: the northern zone (Guinea savanna and Sudan savanna agroecological zones), with one rainy season, and the southern zone (rainforest, coastal savanna, semideciduous forest, and transitional zones), with two rainy seasons. For the southern part, the first (major) rainy season begins in March and ends in July, and the second (minor) one starts in September and ends in November. For the northern part, the rain starts in April, peaks around August, and declines in October. Based on the rainfall distribution pattern in an area, farmers plan their farming activities to coincide with the rains. Hence, the monthly labor requirement in a particular belt is dependent mostly on the rainfall distribution pattern, although other factors, such as farm technology, may also influence it.

Farmers throughout the country mostly start their land preparation activities in the dry season in anticipation that sowing time will coincide with the first rainfall and soil moistures. For farmers in the southern zone (the high cocoa, moderate cocoa, vegetable, high maize, and southern part of Volta valley systems), land preparation mostly starts in February and continues through April. In the high cocoa and moderate cocoa belts, in which tractors cannot be used for land preparation, land preparation activities begin a month ahead of the others (in January) in order not to delay sowing.

Results of our survey show that land preparation activities were carried out at different times in different parts of the country but usually started in January and continued to June (for the major season), ceased from July to August, and began again from September to December (for the minor season). The peak requirements for land preparation occurred in February for the major season and in November for the minor season (see Figure 5.3). However, the land preparation labor requirement pattern differed from belt to belt. Among the belts in the southern part of the country, land preparation started in February in all except the moderate and high cocoa belts, where it began in January. The highest labor requirement for land preparation in the moderate and high cocoa belts occurred in January while it was in February for the other southern belts. For belts in the northern part of the country—specifically, the high onion and cereals belts—land preparation began in March and April. For belts with two farming seasons, land preparation activities started again in September and lasted through to December.

[13] Less than five percent of farming in Ghana relies on irrigation.

Figure 5.3—Monthly total labor requirements for land preparation, sowing, crop maintenance, and harvesting



Source: Constructed by the authors from own 2009 survey data.

Sowing usually follows immediately or a few weeks after land preparation; accordingly, our survey shows that sowing started in February, ran through until it stopped July, and then began again in December for the minor farming season. The peak requirements for sowing occurred in April and December, in the major and minor farming seasons respectively; however, the labor requirement in April was higher than in December. Among the systems in the south, sowing activities started in February and

ran through to June, with the highest labor requirement occurring in April. For the cereals and high onion systems in the north of the country, sowing activities started in March and April, with the most labor demanded in March and May, respectively.

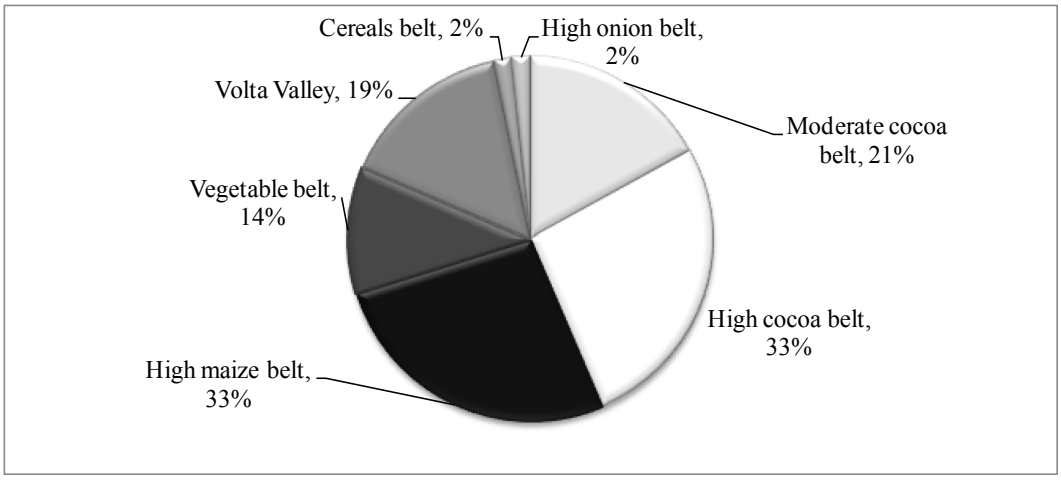
Crop maintenance activities started in February and continued to roughly November, depending on the type of crop and the farming belt. The highest labor requirement for crop maintenance occurred in July.

The last farming operation, harvesting, normally started in April and ended in December for most crops in the sample, with the exception of cassava, for which the growing season can go from six months to one year, depending on the variety. For the southern belts, harvesting started in April, while in the cereals and high onion belts, harvesting usually started in August.

In conclusion, months with the highest reported labor requirements in our sample were February for land preparation, April for sowing, July for crop maintenance, and December for harvesting. Wide disparity was found in terms of the labor requirements between belts in the north and those in the south of the country. For example, land preparation required the most labor in February in the north but in March in the south.

In response to high seasonal labor demand and spatial differences in labor requirements, farmers hire migrant workers from other communities and villages. In our survey, 185 out of the 210 farmers interviewed reported hiring labor. Among these 185 farmers, 22 percent indicated that the laborers they hired did not reside in the community and 4 percent of them indicated that their labor came from neighboring countries, particularly Togo. Figure 5.4 shows the distribution of agricultural immigrants used as laborers in different belts.

Figure 5.4—Proportion of farmers indicating the use of migrant labor in the different belts



Source: Constructed by the authors from own 2009 survey data.

In the high cocoa system, 33 percent of farmers indicated that they hired migrants, mainly from the northern part of the country. Migrants to the moderate cocoa system come from the following places, in order of prevalence: the northern zone, the Volta valley, and Togo. For the cereals and high onion systems, migrants hired came mostly from neighboring communities.

In conclusion, the waves of agricultural activity in our survey started as early as January, with land preparation for the major season in the southern part of the country, and ended in December, with intense harvesting activity in most of the country. Between April and July, agricultural activities intensified all across the country. During this period, labor demand was high and farmers were faced with multiple tasks in different fields to be performed at the same time. Farmers responded to this challenge by hiring laborers from outside their community, outside their region, and even outside the country. Surveyed farmers indicated, however, that these laborers did not always entirely meet their needs.

6. SUMMARY AND DISCUSSION

As one would expect, the total labor requirements varied among cropping systems. The requirements were particularly high in the two cocoa cropping systems in the forest zones. The requirements were particularly high for land preparation and crop maintenance. When all the systems are considered together, however, crop maintenance required more labor than land preparation. Looking across crops, land preparation and crop maintenance took the largest share of labor for cassava, yam, and maize. Rice, on the other hand, required large shares of labor for land preparation and harvesting.

In response to apparent unavailability and cost of labor, farmers are increasingly demanding mechanical traction for land preparation in Ghana. Other field operations continue to rely on manual labor, although mechanical shelling of maize is becoming common in some areas. With the government importing combine harvesters for rice, harvesting of crops is also likely to be mechanized to a significant extent, although the rice cultivation area is still quite small. Because land is still abundant, mechanization may lead to extensification, that is, increase the area planted and therefore the labor requirements for other operations as well. However, mechanization is not feasible in all regions, particularly with available equipment.

The benefits of mechanizing land preparation depend on both the system and the type of crop cultivated. For example, mechanization of land preparation for cassava in the vegetable belt resulted in a 25 percent savings on labor, entailing a 12 percent reduction of cost. In the cereals belt, mechanization reduced labor demanded for land preparation by only 6 percent, entailing a cost reduction of 3 percent. Within systems, there is also variation across crops. While in the cereals belt mechanization reduced land preparation labor demand and cost for cassava by 6 percent and 3 percent, respectively, for maize it reduced labor demand and cost by 25 percent and 35 percent, respectively.

Where mechanization is not feasible for land preparation or not yet adopted for other field operations such as weeding, an alternative and common substitution for labor in crop production is herbicides. Herbicides are used to clear land for planting as well as to control weeds in standing crops. The use of nonselective herbicides to clear land has been tested in multiple projects in the high maize belt in the Brong Ahafo. In our survey, we found that where herbicide was used, its application reduced labor requirements for land preparation by as much as 24 percent. Herbicide technology could be particularly useful in forested zones, where tractors cannot be used to plow lands. Selective herbicides were used to control weeds in all the crops examined and in all the belts except the vegetable belt. They reduced labor use by as much as 40 percent and cost for crop maintenance by up to 17 percent.

Farmers seem to reduce costs by substituting either mechanical traction or chemical control of weeds for some of the required labor. Our analysis, however, does not take into consideration the effect this substitution may have on the yields and therefore on the returns on or the sustainability of these practices. Those are important topics for future studies.

Because the bulk of agriculture in Ghana is rainfed, the demand for labor is seasonal, with high demand for land preparation between January and March, for sowing and crop maintenance between April and August, for crop maintenance and harvesting between October and December. In April, for instance, land preparation, sowing, crop maintenance, and harvesting are all taking place in almost all regions nationwide, putting strain on the labor supply. Workers migrate in response to such seasonal demand, but there is still not enough labor to satisfy the demand in all areas. Rice growers in particular suggested that they often have to delay both planting and harvesting because of labor shortage.

The findings suggest that cropping systems have different total labor requirements, and the requirements for broad categories of operations, such as land preparation and crop maintenance, also vary considerably. These variations can be the basis for prioritizing investments in developing mechanization. However, more systematic analysis at district or regional levels is required. Our analysis suggests, for example, that labor requirements in the north may look lower than they actually are because the survey captured only 36 percent of the crops in the system. Additionally, crops such as soybeans, whose cultivation has been expanding in recent years, have unique mechanization requirements.

The greatest demand for mechanization now comes for land preparation. As noted above, increased mechanization of land preparation may bring additional area into production, further increasing labor requirements for rest of the operations. In the forest zone, mechanization is not feasible with the currently available tractors. It may be useful to consider the introduction of smaller tillers to at least partially mechanize some of the operations.

Thus far, government attention to mechanization has also focused on land preparation, but the requirements for crop maintenance are far higher. The labor requirements for operations such as planting are likely to be even higher than we have observed if improved crop husbandry practices are adopted. Higher yields would further increase the labor requirements for harvesting, threshing, and so on. Shelling of maize, for example, has been mechanized in many parts of the country. Strategies for mechanization need to consider introduction of implements for weeding in particular.

This has implications for the viability of mechanization centers with only large tractors. If plowing is the only operation the tractors can undertake, they cannot be fully utilized throughout the year. They need to be equipped with threshing and water lifting capability to meet other needs and become more viable.

REFERENCES

AESD (Agricultural Engineering Services Directorate). 2008. Presentation at Ministry of Food and Agriculture performance review workshop, February 11–15, Kumasi, Ghana.

_____. 2010. "Review of Agricultural Mechanization in Ghana. Ghana Ministry of Food and Agriculture Performance Review." Report, Agricultural Engineering Services Directorate, Kumasi, Ghana.

Bisho-Sambrook, C. 2005. *Contribution of Farm Power to Smallholder Livelihoods in Sub-Saharan Africa.* Agricultural and Food Engineering Technical Report 2. Rome: FAO.

Benneh, G. 1971. "Land tenure and Sabala Farming System in the Anlo Area of Ghana: A Case Study." *Research Review* 7 (2):134-146.

Binswanger, H. P. 1986. "Agricultural Mechanization: A Comparative Historical Perspective." *World Bank Research Observer* 1 (1): 27–56.

Binswanger, H. P., and L. P. Pingali. 1984. "The Evolution of Farming Systems and Agricultural Technology in Sub-Saharan Africa." In *Policy for Agricultural Research*, edited by. V. Ruttan and C. Pray. Washington, DC: World Bank.

_____. 1988. "Technology, Investment and Institutional Priorities for Rapid Growth in Sub-Saharan Africa." *Research Observer* 3 (1): 81–98.

Boateng, E. A. 1962. "Population and Land Use in the Forest Zone of Ghana." *Bulletin of the Ghana Geographical Association* vii. Accra, Ghana.

Boserup, E. 1965. *The Conditions of Agricultural Growth: The Economics of Agrarian Change under Population Pressure.* London, UK: George Allen and Unwin.

Dickson, K. B., and G. Benneh. 1988. *A New Geography of Ghana*. Essex, UK: Longman Group Ltd.

Dixon, J., A. Gulliver, and D. Gibbon. 2001. *Farming Systems and Poverty: Improving Farmers' Livelihoods in a Changing World*. Rome: FAO; Washington, DC: World Bank.

FAO (Food and Agriculture Organization). 2010. Investment in Agricultural Mechanization in Africa. Research Report Presented at the Centre for Agricultural Mechanization and Rural Technologies (CAMARTEC), June 3–5, 2009. Arusha, Tanzania.

FAO and UNIDO (Food and Agriculture Organization and United Nations Industrial Development Organization). 2008. *Agricultural Mechanization in Africa: Time for Action, Planning Investment for Enhanced Agricultural Productivity. Report of an expert group meeting jointly held by FAO and UNIDO,* November 29–30, 2007, in Vienna. Rome: FAO.

Gyasi, E. A. 1995. "Farming in Northern Ghana." *ILEIA Newsletter* 4 (11): 23.

Herdt, R. W. 1983. "Mechanization of Rice Production in Developing Asian Countries: Perspectives, Evidence and Issues." In *Consequences of Small Farm Mechanization*, edited by International Rice Research Institute (IRRI). Los Baños, Laguna, Philippines: IRRI.

Ghana, Ministry of Food and Agriculture (MoFA). 2007. *Strategic Framework for Ghana Food Security Action Plan (GFSAP).* Accra, Ghana.

_____2008. *The Medium Term Expenditure Framework for 2008–2010, Annual Estimates for 2008*. Accra, Ghana.

Mrema, C. G., D. Baker, and D. Kahan. 2008. *Agricultural Mechanization in Sub-Saharan Africa: Time for a New Look*. Rome, Italy: UN FAO.

Pingali, P. 2007. "Agricultural Mechanization: Adoption Patterns and Economic Impact." In *Handbook of Agricultural Economics.* Vol. 3, *Agricultural Development: Farmers, Farm Production and Farm Markets,* edited by R. Evenson and P. Pingali. Amsterdam: North-Holland.

Pingali, P. L., Y. Bigot, and H. P. Binswanger. 1987. *Agricultural Mechanization and the Evolution Of Farming in Sub-Saharan Africa.* Baltimore: Johns Hopkins University Press.

Ruthenberg, H. 1983. *Farming System in the Tropics*. Oxford, U.K.: Clarendon Press.

Sims, G. B., and J. Kienzle. 2006. *Farm Power and Mechanization for Small Farms in Sub-Saharan Africa.* Agricultural and Food Engineering Technical Report 3. Rome: FAO.

Twum, A., and O. K. Gyarteng. 1995 "Agricultural Mechanization in Ghana: An Overview." In *Agricultural Mechanization Policies and Strategies in Africa: Case studies from Commonwealth African countries,* ed. G. C. Mrema. London, UK: Commonwealth Secretariat.

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