A SYSTEMS APPROACH TO SMALL FARMER WEED CONTROL

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ABSTRACT

Small farmers in the Eastern Caribbean generally rely on a sequence of manual operations for weed control. Gramoxone is the most commonly used weedkiller, but its use may be limited to land preparation, especially in food crop systems, and in tree crop systems. The labour-intensive nature of the existing systems may lead to delays in weed control, where other farm activities have a prior demand on labour. Changes to the components of weed control systems should recognise the holistic nature of the farm system. Changes should not unduly increase cash costs, unless additional income can be generated, not displace labour that cannot be gainfully employed elsewhere (on the farm), nor adversely affect food supplies and food security.

RESUMEN

Pequeños agricultores de la region Este del Caribe, generalmente siguen y dependen de una serie de operaciones manuales, para el control de las hierbas. El herbicida de mas uso es el Gramoxone, pero su uso puede que se limite a la preparación del terreno a cultivar, especialmente en los sistemas de cultivos alimenticios y de frutales. La naturaleza de la labor intensiva de los sistemas presentes, puede ocasionar retrazos en el control de las hierbas, especialmente, cuando otras labores de finca requieran prioridad. Los cambios en los componentes del sistema del control de hierbas deben hacerse, reconociendo la naturaleza total de los sistemas de la finca. Los cambios ha efectuarse o ya efectuados no deben incrementar indebidamente los gastos monetarios, a no ser que se pueda generar renta adicional, tampoco deben desplazar a los trabajadores a no ser de un trabajo a otro en la misma finca, y ni tampoco deben tener un efecto adverso en el suministro ni en la garantia de obtención de los alimentos.

Keywords: Small farms; Weed control.

Small farmers in the Eastern Caribbean generally have a "system" of weed control, which commences with land preparation and usually ends with a weed fallow when the crop has been reaped. For most small farmers, the system comprises an entire sequence of manual operations but in some countries they may be able to hire a tractor for land preparation. Some use herbicides to augment manual land preparation and weed control operations.

Since weed control is only one activity of many in crop production, it may compete with others for labour, which is usually in limited supply. These other activities may take precedence over weed control. For example, banana cutting must have priority since there is a shipping deadline to meet. Land preparation and planting, at the start of the rainy season, may take precedence over weed control in crops already established. This is simply the farmer optimising the use of a scarce resource over the entire farm. It is also possible that, because the damage due to weeds is apparently less dramatic than that due to, for instance, armworms, leaf-cutting ants or mildew, pest and disease control by chemicals may assume priority over weed control.

Materials and methods

Most of this paper is based on data from a survey conducted in 1984–85 in nine islands of the Eastern Caribbean, namely, Antigua, Dominica, Grenada (and Carriacou), Montserrat, Nevis, St. Kitts, St. Lucia and St. Vincent. A total of 788 farmers (mostly with less than 2.6 hectares) were interviewed, each for a specific production system – which may have been only one of the two or more on the farm (Hammerton, 1985 a, b, c and unpublished).

Results

Table 1 shows the mean rankings given by farmers' to four activities as users of labour. A low value indicates a high rank: that is, many farmers ranked that activity one or two. It is evident that weed control is a major user of crop labour in five islands, and second to land preparation, as a user of labour, in the other four islands. Data on farmers' perceptions of weeds as a source of crop loss are too bulky to present here. In vegetable-based systems, insect pests were generally ranked higher than weeds as sources of crop loss, but in aroid-and banana-based systems, weeds were generally perceived as the major source of loss. Table 2 shows the percentages of farmers using herbicides pre-planting only (i.e. in land preparation), post-planting only (i.e. for "in-crop" weed control), and both pre- and post-planting. Overall, 41% of the farmers surveyed used herbicides: the high values for Dominica and St. Lucia reflect the banana-based systems surveyed in these two countries. In all the systems studied in Antigua, at least 50% of farmers used herbicides. Relatively few farmers used herbicides post-planting only: much more frequent was pre-planting use only or both pre– and post-planting use.

A total of 18 herbicides was used (Table 3). "Gramoxone" was the most commonly used: 310 out of 321 (or 96%) of farmers using herbicides used "Gramoxone" and for most farmers it was the only herbicide. After Gramoxone, the most commonly used were "Roundup" and "Reglone" - both mainly used in Antigua. All the other herbicides recorded a frequency of use below 3%. Overall, 27% of farmers used more than one herbicide (Table4). Noteworthy is the 34% of surveyed farmers in Antigua who used three herbicides – with a further 7% using more than three. This may reflect availability, but availability may reflect demand.

Table 1. Mean rankings[1] of four activities as users of labour: means of production systems, by countries.

	ACTIVITY				
	Land preparation	Pest/disease control	Weed control	Harvesting	No. of farmers
Antigua	3.0	2.7	1.3	2.8	110
Dominica	1.3	3.7	1.8	3.1	82
Grenada	1.3	3.6	1.7	3.6	137
Carriacou	2.1	-	1.4	2.2	27
Montserrat	2.2	3.5	1.5	3.0	94
Nevis	2.2	3.7	1.2	3.0	49
St. Kitts	1.5	3.5	1.8	3.3	73
St. Lucia	1.8	3.2	1.9	3.1	78
St. Vincent	1.8	3.7	1.6	3.5	106
Mean[2]/Total	1.9	3.4	1.6	3.2	756[3]

(1) Farmers were asked to rank on a scale of 1 (biggest user) to 5 (smallest user).
(2) Weighted means
(3) Less than total number of farmers due to non-responses

Table2. Percentages of farmers surveyed using herbicides pre-planting only, post-planting only and both pre-and post-planting, and the total using herbicides, by countries.

	Pre-only	Post only	Both Pre- and post-	Total uising	Total Nos. of farmers
Antigua	23	5	36	64	118
Dominica	12	15	46	73	97
Grenada	15	-	3	18	137
Carriacou	7	-	-	7	27
Montserrat	10	3	8	21	95
Nevis	2	-	2	4	50
St. Kitts	3	3	4	10	75
St. Lucia	22	11	39	72	79
St. Vincent	38	3	15	56	110
Mean/Total	17	5	19	41	788

Table 3. The herbicides used, by mode of action.

Contact	Soil-acting	Systemic
Gramoxone (310)***	Dacthal (7)	Agroxone (5)
Kerosene (1)	Eptam (1)	2,4-D (1)
Reglone (44)	Gesagard (3)	Dalapon ** (1)
	Gesaprim (1)	Fusilade (3)
	Hyvar- X (1)	Round-up (56)
	Karmex (1)	
	Lasso (9)	
	Maloran (3)	
	Tok* (8)	

* can have some contact action
** can have soil activity
***Number in parentheses indicates number of farmers using each herbicide

Table 4. Percentage of farmers using herbicides, who used one, two, three or more than three herbicides, and the number of herbicides used, by countries.

	Percentage of farmers using herbicides using the following number of herbicides				Number of herbicides used[1]
	1	2	3	>3	
Antigua	41	18	34	7	9
Dominica	76	18	6	-	5
Grenada	76	24	-	-	3
Carriacou	100	-	-	-	1
Montserrat	55	30	10	5	4
Nevis	100	-	-	-	1
St. Kitts	71	29	-	-	3
St. Lucia	93	7	-	-	3
St. Vincent	89	6	2	3	5
Mean	73	15	10	2	18[2]

[1]Including Gramoxone
[2]Total number of different herbicides used by farmers in the survey

Land Preparation Systems

Fig. 1 gives examples of the land preparation systems used in different production systems. Only in Antigua, Nevis and St. Vincent were significant numbers of farmers using tractors for primary cultivations, recorded. Elsewhere, manual methods were almost universal. It is evident that there were many variants. In Antigua for example (Fig. 1a), a few farmers planted vegetables apparently with no further work following a tractor cultivation; more common was to form beds and plant. Other farmers used a heavy hoe or forked before forming beds. A few applied a herbicide – but it is not clear which – before hoeing and/or forking and planting. In St. Lucia (Fig. 1d), in root crop-based systems, cutlassing was invariably the first operation. This was followed **either** by burning, forking, ridging or moulding, **or** burning was omitted, and the weeds incorporated or removed. In St. Vincent, in peanut-based systems (Fig. 1e), cutlassing and burning, were followed by hoeing and herbicide (Lasso) application, **or** by tractor cultivation, in some cases followed by forking, **or**, by forking or hoeing, all before ridging or preparation of planting holes, and planting. An alternative was tractor cultivation, followed by herbicide application and by ridging or planting on the flat.

Post-planting Weed Control Systems

For in-crop weed control, the systems are less clear-cut, perhaps because they depend on weed growth, the stage of crop growth, and variations in crop duration. Also weeds are sometimes allowed to grow during the latter part of crop growth to provide forage, or for soil conservation during the fallow period. Fig 2 illustrates some of the systems observed. In Banana-based systems in Dominica (Fig. 2b) cutlassing is the most commonly used first operation, to be followed by other manual operations, moulding-up or Gramoxone. These operations, in turn, are followed by mulching, hand-pulling or moulding-up, and the cycle may be repreated – or one or more specific activities may follow. An alternative is Gramoxone, followed by a second Gramoxone application or manual operations. These again may be repeated. In aroid-based systems in St. Vincent (Fig. 2e) hand-pulling may be the first operation, following by hoeing and moulding-up, or by an early moulding-up. Fewer farmers use Gramoxone early, followed by hoeing and moulding-up or these two operations occur in the reverse order. A few farmers hoe, handpull and mould-up. Another example of the variations recorded is in the corn/pigeon pea systems in Carriacou. Most farmers hoe and mould-up first, with subsequent variations which include cutlassing, hand-pulling and hoeing (Fig. 2a). A minor variant is cutlassing first, followed by moulding-up, and, later, in a few cases, by hoeing.

Thirty-one per cent of farmers did not allow weeds to grow between crop seasons (Table 5). The percentage was least in Carriacou, where 67% allowed weeds to grow to provide animal feed. A weed fallow for feed was relatively uncommon in Dominica and St. Lucia. Except for Carriacou, at least 40% of the farmers surveyed allowed weeds to grow to "rest the soil" (i.e. restore fertility), and, except for Nevis and St. Kitts, less than 40% allowed weeds to grow to "hold the soil" (i.e. as a conservation or anti-erosion measure).

Discussion

How can these existing systems be improved at acceptable cost and consistent with the farmers' overall objective? Changes to the present production system may be acceptable if there are cost savings and/or increase in income, but food security must be safeguarded. Reductions in labour requirements may be acceptable if the labour saved can be usefully employed elsewhere, but savings in family labour will not give cash savings.

There are several components that can be considered to improve weed control systems. These include –

– use of power, especially for land preparations;

Table 5. Percentages of farmers surveyed not allowing weeds to grow between crops and reasons for allowing weeds to grow between crops, by countries[1]

	Nos. allowing	Reasons for allowing			No. of farmers
		Animal feed	To rest the soil	To hold the soil	
Antigua	33	20	47	27	114
Dominica	25	17	61	29	96
Grenada	40	32	46	22	130
Carriacou	15	67	4	22	27
Montserrat	28	34	42	38	85
Nevis	20	33	53	61	49
St. Kitts	26	32	57	43	72
St. Lucia	39	10	41	34	79
St. Vincent	28	38	58	19	106
Means[2]	31	28	49	31	758[3]

(1) Percentages do not sum to 100% as many farmers allowing weeds to grow gave two or three reasons.
(2) Weighted means
(3) There were some non-responses.

- improved hand tools;
- herbicides for land preparations;
- herbicides for post-planting weed control;
- minimum tillage;
- mulching; and
- live mulches and intercrops.

The use of power tillers and walking tractors is a possibility where soil texture and topography permit their effective use. Capital costs are relatively high for farmers with limited incomes. Experiences in St. Vincent (CARDI, 1984a) with walking tractors suggest overuse: they were used where cultivation was not really necessary. In some places as in St. Kitts (CARDI 1984c) power tillers are used for pre-planting and for inter-row weed control.

There are several low-cost hand tools – rotary hoes, scuffles etc. – that can facilitate inter-row weed control, provided that the soil is friable and weeds are small. Row planting is desirable, but low cost hand pushed seed drills or planters are also available. Experience in St. Kitts has been encouraging (CARDI, 1984c), but the potential for such tools on heavy soils in wet weather is probably low. Weed wipers are potentially useful for in-crop weed control, especially of perennials, but there are a limited number of herbicides suitable for use in wipers – and they tend to be expensive materials.

As adjuncts to land preparation, herbicides offer great scope, but entail a cash cost. They may not save the labour for land preparation, but may reduce in-crop weed control costs. Farmers in Antigua use "Round-up" in land preparation to control perennial weeds, and farmers elsewhere use "Gramoxone" (and to a lesser extent, "Reglone") in land preparation. "Fusilade", and other "recent" grass killers, and possibly 2, 4–D, could also be used in this way. Dalapon should be relatively inexpensive, and might also be useful in land preparation for tolerant (non-graminaceous) crops.

Post-planting, many farmers rely, at least partially, on directed or shielded sprays of Gramoxone, but such treatments are only practical in tall growing crops. Even though Gramoxone does not control – or gives only temporary control of - many weeds, it may save hand labour. There is clearly a scope for the use of residuals in many crops. Few banana growers apparently use residuals, in spite of WINBAN recommendations (WINBAN, 1985). Only six out of ninety farmers with banana-based systems in Dominica and St. Lucia used residuals. This may reflect intercropping – but few farmers would intercrop all their bananas.

For most broad-leaf crops, over-the-top grass killers are now available (by apparently little used). There are few broad-leaf weed killers locally available for use in broad-leaf crops. "Dacthal" – a broad spectrum herbicide suitable for use in several vegetable crops – is little used. No doubt the limited range of herbicides available, and the sporadic supply, reflect a lack of demand.

Herbicide application by small farmers in the Eastern Caribbean is invariably by knapsack sprayers. These require a supply of water, which is often available only at a distance. Controlled droplet applications (e.g. the Herbi) would obviate the need for water, but require batteries and special formulations not locally available. The Birky does not require special formulations and uses volume rates (of water) of only 20 to 30 l ha^{-1}. Batteries are not required. Birky sprayers are not (yet) available in the Eastern Caribbean. It is not (yet) clear whether they can be used with contact herbicides. The use of very low volume nozzles, in conventional knapsack sprayers, is another way of reducing volume rates, However this may not be effective with contact herbicides especially where weeds are large.

Minimum tillage is used in some crops especially bananas, but tillage may be necessary if an intercrop is to be taken. It is probable that some farmers cultivate unnecessarily – perhaps because they prefer

to plant into clean, trash-free land. Minimum tillage for aroids was successful in St. Vincent (CARDI, 1984b), and many other crops can probably be established this way. Herbicides especially "Round-up" can minimise perennial weed growth during the early stages of crop establishment.

Mulching has been shown to increase yields of certain vegetable crops and to reduce the number of weedings required, in Antigua (CARDI, 1983). Under wetter conditions, mulches may harbour slugs. The practice merits evaluation for several crops under varying agro-ecological conditions, not only as a means of reducing weeding, but to protect the soil surface and reduce capping.

Live mulches, especially of legumes, are an attractive idea. Possible disadvantages include competition for water, and the costs of establishment and management. Management is definitely a problem with viny legumes such as kudzu *(Pueraria phaseoloides)* and dolichos *(Lablab niger)*. More recently perennial peanuts *(Arachis* spp) have been used: these form a dense, low ground cover. There is the risk that live mulches could become weeds (i.e. persist when no longer required). Intercrops are commonly used, less as a weed control component than as a means of increasing land utilization. They are valuable in generating income during the establishment phase of the main crop, especially bananas and sugar-cane (Rao and Edmunds, 1980).

The diversity of farm systems, of resources and farmer objectives, implies that there are no simple or universally acceptable systems that can be recommended. Guidelines on the options, and on the criteria to be applied in developing recommendations, need to be worked out.

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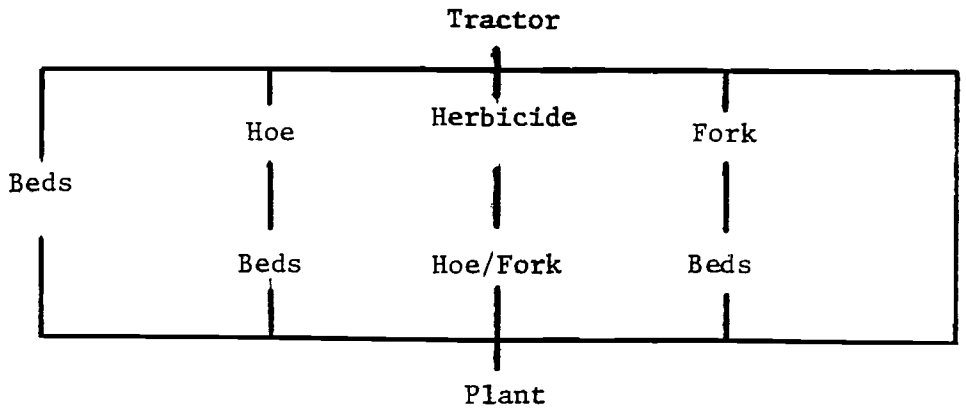
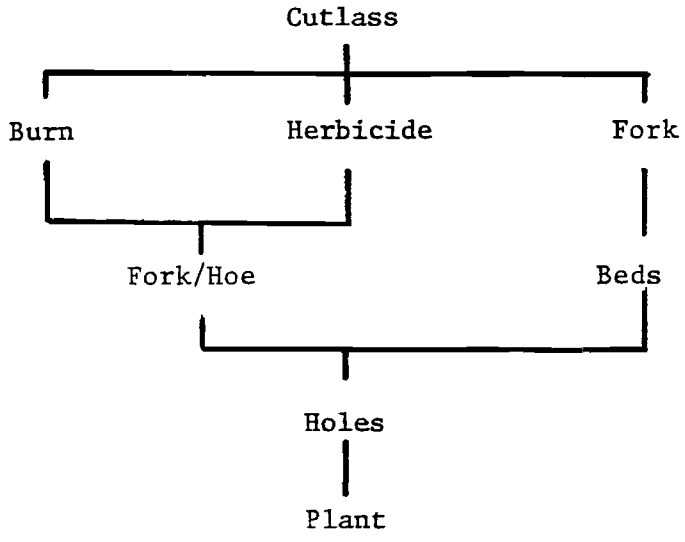
(a) Antigua: vegetable-based systems



(b) Dominica: banana-based systems



(c) Nevis: cotton-based systems

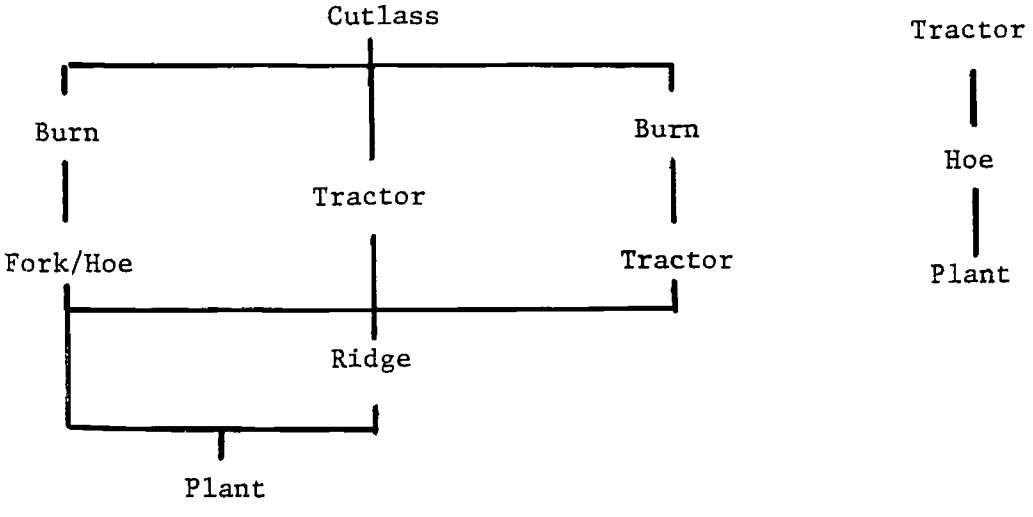
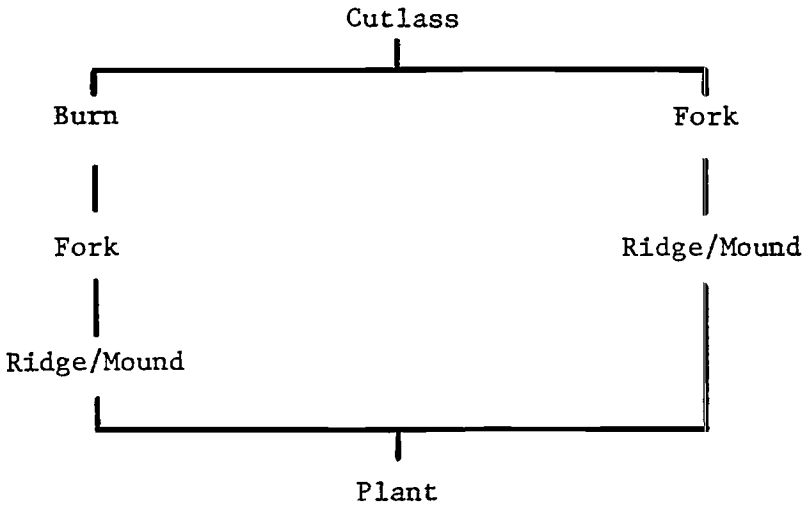
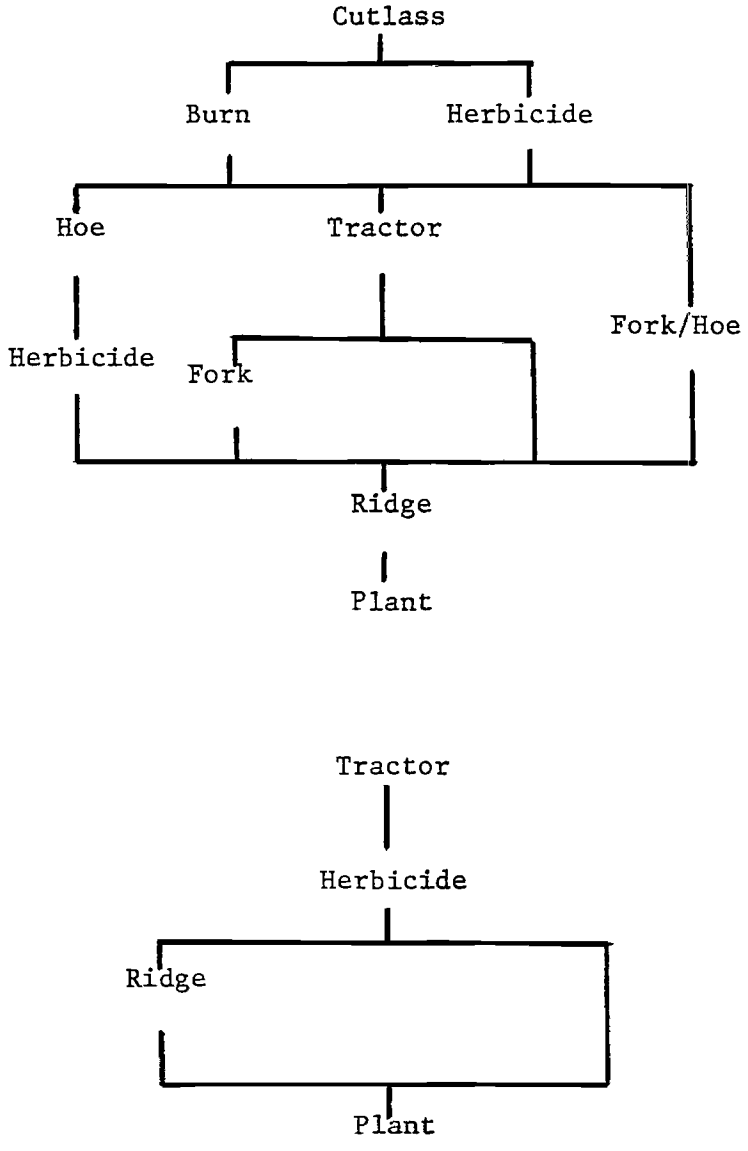


Fig. 1 Land Preparation Systems in selected production systems in the Eastern Caribbean. Frequency decreases left to right.

(d) St. Lucia: root crop-based systems



(e) St. Vincent: peanut-based systems



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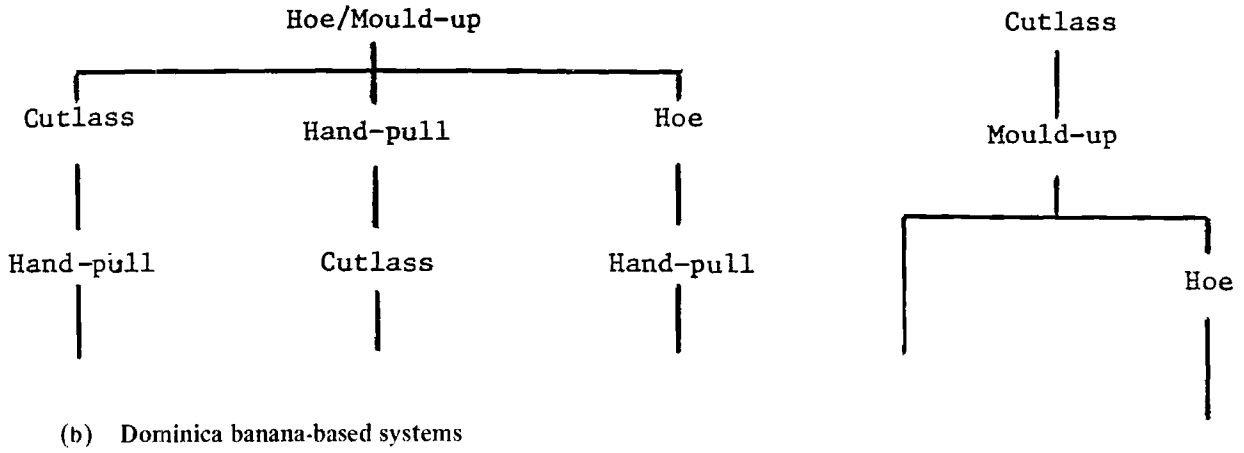
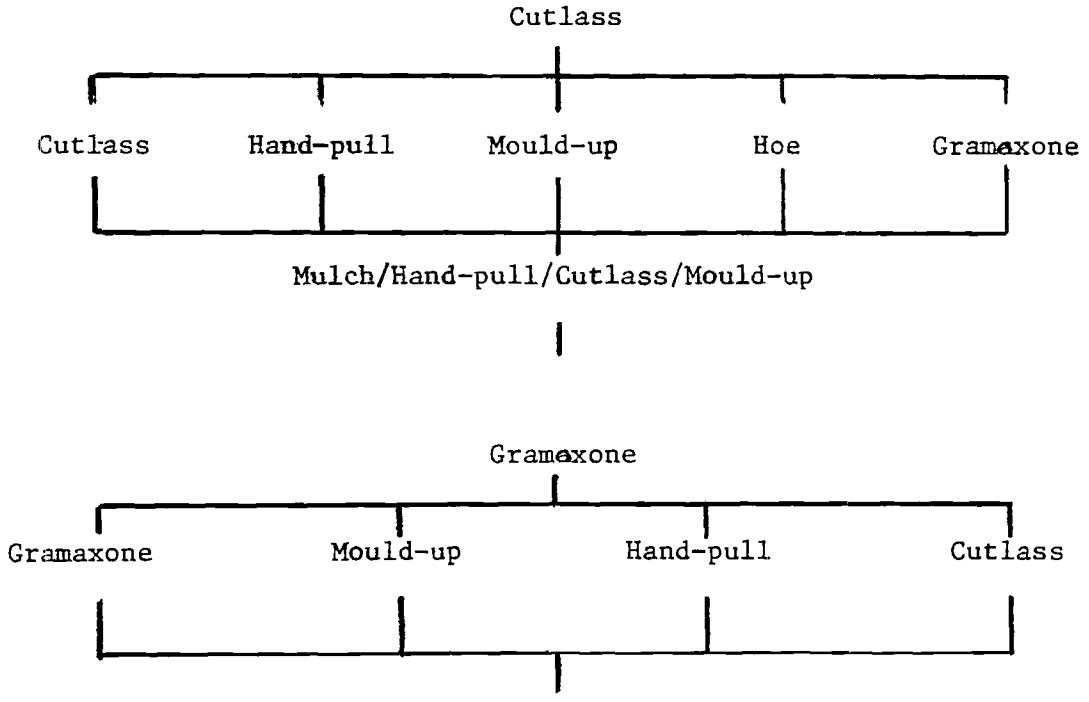
(a) Carriacou: corn/pigeon pea systems



(b) Dominica banana-based systems



(c) Montserrat: vegetable-based systems

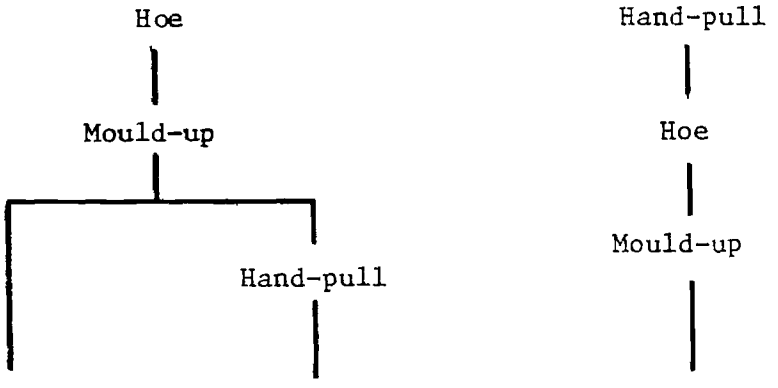


Fig. 2 Weed Control Systems ("in-crop") in selected production systems in the Eastern Caribbean. Frequency decreases left to right.

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— Faculty of Agriculture, University of the West Indies

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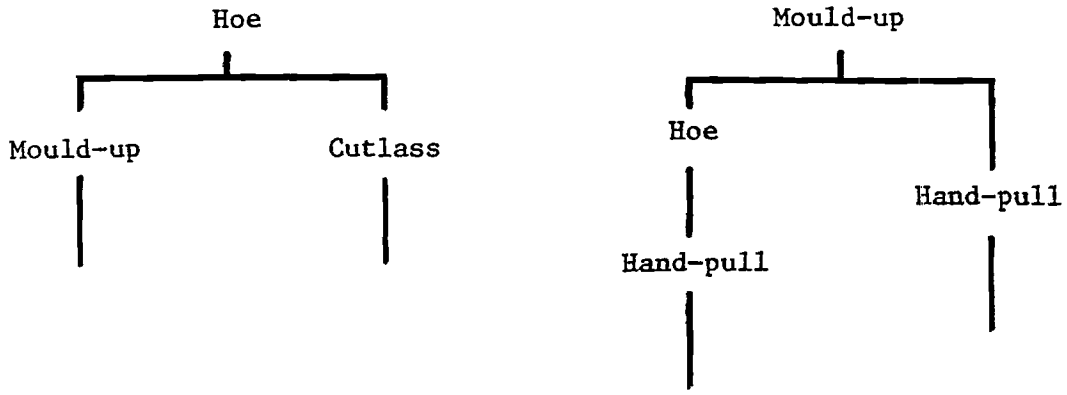
(d) Nevis: cotton-based systems



(e) St. Vincent aroid-based systems

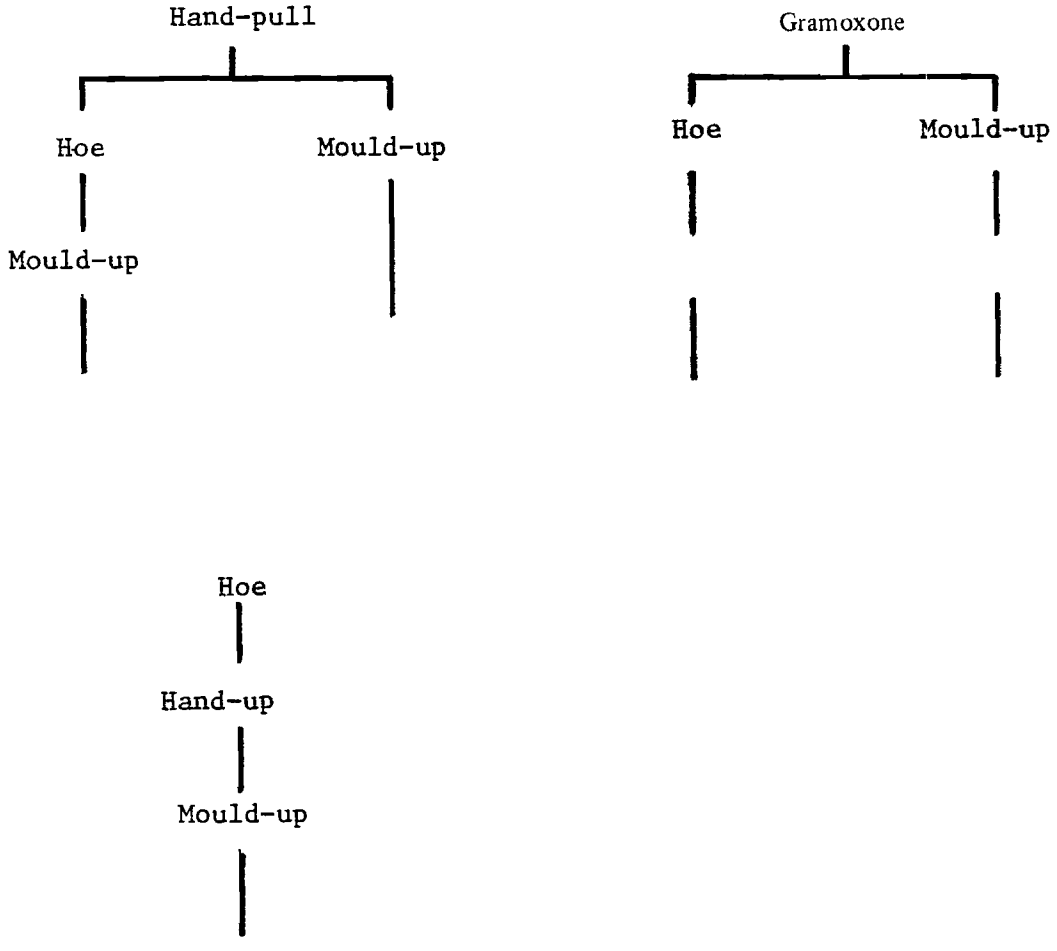


Fig. 2 Weed Control Systems ("in-crop") in selected production systems in the Eastern Caribbean. Frequency decreases left to right.