IMPROVEMENT AND FERTILIZATION OF UPLAND SOILS IN THAILAND

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Introduction

In recent years, agricultural production of Thailand has been diversified in a variety of crops; as a result, the total production of rice, the staple commodity, has been on the decline. Since the areas for cultivation of upland crops were expanded much more than those for rice, the ratio of the rice planted area to the total planted area decreased from 80% in 1962 to 60% in 1976 and presently stands at 60%. In view of the past trend and agricultural policy of the Fourth National Economic and Social Development Plan (1977–1981) which puts emphasis on diversification, this trend is expected to continue in the future.

On the other hand, the total planted area should remain at the present level of 17.5 million hectares because rapid expansion of planted area in the 1960s had already ceased in the mid-1970s, and now the government is taking measures to prevent conversion from forest to planted area as stated in the Fourth Plan (Appendix I).

Appendix I

Planted Area and Average Yield of Major Crops

(unit: million hectares and ton/ha)

Major Crops	1962		1966		1970		1975		1980	
	area	yield	area	yield	area	yield	area	yield	area	yield
Paddy	6.59	1.67	7.43	1.61	7.49	1.81	8.90	1.72	9.22	1.88
Maize	0.33	2.03	0.65	1.72	0.83	2.34	1.31	2.18	1.58	2.04
Cassava	0.12	17.06	0.13	14.67	0.22	15.32	0.59	13.65	1.00	13.94
Sugar cane	0.06	30.71	0.06	43.89	0.14	47.75	0.55	36.13	0.54	33.01
Soybean	0.03	1.08	0.05	0.83	0.06	0.86	0.12	1.12	0.19	1.04
Cotton	0.06	0.70	0.08	1.06	0.03	0.87	0.03	1.16	0.13	1.34
Peanuts	0.09	1.29	0.16	1.40	0.10	1.20	0.12	1.21	0.20	1.34
Mungbean	0.05	1.08	0.14	0.97	0.24	0.63	0.16	0.74	0.51	0.74
Kenaf	0.11	1.18	0.53	1.25	0.42	0.90	0.33	0.94	0.26	1.27

Production of major crops had increased considerably with the expansion of the planted area; however, yields of major crops except sugar cane had not increased, and yields of some other crops had actually decreased. Since more and more land with high fertility was successively converted into cultivated areas, the average yields of crops have not so far shown any drastic decrease. In fact, however, the lack of attention to the problems of soil conservation and manage-

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ment by the farmers had caused rapid productivity deterioration in most of the upland areas particularly the 3.8 million hectares under field crop cultivation.

In order to develop stable forms of land use methods for a range of soils and ecological zones and increase the crop production of each area, many difficulties have to be overcome, politically and socio-economically. Since 70% of the total Thai population consists of small farmers with a subsistence level income, development will have to be a gradual transformation through step-by-step improvements in the existing farming systems. Sustaining agricultural yield in the heat, humidity, and high rainfall of the tropical environment is a particular problem. Soil and water conservation management and the use of fertilizer are essential but expensive and require adequate knowledge. Farmers need better assurance against crop damage by adverse environmental conditions before any further commitment to the improvement of productivity can be made. Market outlets, credit, communication and rural infrastructure must also be made available to the small farmers who have had little chance to improve their standard of living.

Upland soils of Thailand

Most of the upland soils are found along the foot of mountains and slope land of hills, plateaus, river levees, and dunes – a total area of approximately 5.4 million hectares presently under cultivation. Cultivation of field crops accounts for 3.78 million hectares, fruit crops for 1.62 million hectares and vegetable crops for 36,000 hectares. The production of maize, cotton, cassava, kenaf, food legumes and other upland crops is almost entirely under rainfed conditions.

Twelve great soil groups were recognized by Moorman and Rojanasoonthon (1972). These are classified as Alluvials, Regosols, Low Humic Gleys, Grumusols, Rendzinas, Noncalcic Browns, Brown Forests, Reddish Brown Lateritics, Red Yellow Podzolics, Red Yellow Latosols, Gray Padzolics, and Reddish Brown Latosols. Change to the new and more detailed 1977 U.S. Soil Taxonomy system of classification is well underway; the approximate equivalents are shown in Table 1.

Table 1 Approximate great soil groups equivalent between the new U.S. Soil Taxonomy and the old Dudal and Moorman classification.

U.S. Soil Taxonomy	Dudal & Moorman
Plinthustults	Some Red Yellow Podzolics, Reddish Brown Lateritics
Paleustults Haplustults Paleudults Tropudults	Some Red Yellow Podzolics, Reddish Brown Lateritics Latosols and Gray Podzolics
Palehumults	Some Reddish Brown Lateritics
Paleustalfs Haplustalfs	Non-Calcic Brown
Dystropepts Eutropepts Ustropepts	Some Regosols, Gray Podzolics and Red Yellow Podzolics
Quartzipsamments	Some Regosols
Ustifluvents	Alluvial Soils
Troporthents	Lithosols
Calciustolls	Rendzinas
Haplustolls	Brown Forest
Chromudents Pelluderts	Grumusols
Tropohumods	Ground Water Podzols
Haplorthox	Latosols

Some physical and chemical properties of these soils determined by Kubota *et al.* (1979) and Ogawa *et al.* (1975) are shown in Tables 2 and 3.

The majority of upland soils are dominated by low activity clays, and have low base status and low water and nutrient retention capacity. Relatively high base status soils (Alfisols, some Mollisols and Vertisols) occupy only a small percentage of the total upland area. Because of the high energy load of tropical rainstorms, most of the upland soils are structurally unstable to raindrop impact whenever they are exposed by excessive cultivation involving soil disturbance. Thus, it is essential to maintain adequate soil cover and high organic matter content in these soils.

Table 2 Physical properties of upland soils in Thailand (after Kubota *et al.*, 1979)

Great soil groups	No. of samples	Bulk density (g/cm^3) surface 1)	Bulk density subsoil	Non-capillary pore (vol%) surface	Non-capillary pore subsoil	k (cm/s) 2) of surface soil	AWHC (mm) 3) 1 m profile	Dispersibility of Ap Soil to water (%) 4)
Regosols	2	1.64	1.66	23.3	23.1	10^{-3}–10^{4}	58.2	68.6
Grumosols	1	0.97	0.99	7.6	2.5	10^{-6}	107.2	6.8
Rendzinas	2	1.19	1.26	–	–	10^{-5}	111.0	4.7
Brown Forest	1	1.42	1.23	10.5	7.9	10^{-5}	83.7	23.7
Noncalcic Brown	5	1.57	1.61	7.9	4.2	10^{-3} – 10^{-7}	106.2	24.8
Gray Podzolics (SE)	6	1.70	1.64	9.3	10.9	10^{-3} – 10^{-6}	71.8	39.6
Gray Podzolics (NE)	10	1.62	1.51	16.8	21.2	10^{-3} – 10^{-4}	87.3	50.1
Red-Yellow Podzolics	12	1.51	1.47	13.5	14.7	10^{-3} – 10^{-6}	85.4	28.5
Reddish Brown Lateritics	9	1.27	1.22	13.8	15.8	10^{-3} – 10^{-5}	77.8	17.0
Reddish Brown Latosols	2	0.98	0.96	26.3	29.6	10^{-3} – 10^{-4}	80.5	10.8
Red-Yellow Latosols	2	1.56	1.42	14.6	20.7	10^{-3} – 10^{-4}	106.1	29.1

1) Subsurface layer 2) Hydraulic conductivity at saturation 3) Available moisture holding capacity
4) Middleton's method; easily water dispersible clay + silt / (total clay + silt)

Table 3 Some chemical properties of upland soils in Thailand (after Ogawa *et al.*, 1975)

Great soil groups	No. of samples	pH (1:1) $\bar{x}$	pH range	CEC (meq/100g) $\bar{x}$	CEC range	Base saturation (%) $\bar{x}$	Base saturation range	% O.M. $\bar{x}$	% O.M. range	Bray II-P (ppm) $\bar{x}$	Bray II-P range	Exchangeable K (ppm) $\bar{x}$	Exchangeable K range
Alluvial	3	7.0	6.3–7.5	10.8	6.5–15.8	122	111–130	2.1	1.4–3.5	108	41–207	196	40–402
Regosols	3	6.2	5.9–6.7	1.0	0.5– 1.8	253	26–653	0.6	0.5–0.7	4	4– 5	21	10– 30
Low Humic Gley	10	5.2	4.5–6.5	2.0	1.0– 4.0	67	21–155	1.1	0.4–1.4	20	2– 36	68	8–308
Grumosols	1	7.9		43.0		112		1.2		12		200	
Rendzinas	2	7.5	7.4–7.5	37.2	25.7–48.7	107	86–128	3.7	2.5–4.8	17	14– 19	440	100–780
Brown Forest	3	6.3	5.7–7.1	16.9	7.6–26.2	96	76–112	0.8	1.5–1.8	8	2– 16	254	200–424
Noncalcic Brown	7	6.4	5.1–7.8	8.8	2.0–14.6	121	40–188	1.7	0.9–2.6	81	4–340	229	12–558
Gray Podzolics	36	5.3	4.2–6.6	2.4	0.6– 5.7	90	25–259	1.3	0.4–3.2	27	2–194	64	20–267
Red-Yellow Podzolics	41	5.4	4.3–7.7	6.8	1.1–23.9	77	8–325	2.8	0.4–5.2	30	4–206	108	30–220
Reddish Brown Lateritics	4	5.1	4.7–5.3	8.2	6.8–11.0	62	47– 80	2.3	1.7–2.7	35	3– 90	254	100–369
Reddish Brown Latosols	1	5.5		10.8		26		1.8		49		512	
Red-Yellow Latosols	5	5.7	4.9–6.4	2.8	1.2–5.6	103	39–161	1.4	0.6–2.5	17	5–41	74	14–185

Deterioration of upland soils

Land development by deforestation of rainforest and the dryer deciduous forest began only in the 1960s but has created rapid ecological imbalance regarding the hydrological cycle, energy balance, and biotic environment. Drastic changes were observed due to deforestation with regard to decrease in infiltration rate, soil physical characteristics such as bulk density and moisture retention characteristics, and in micro-climate. These conditions resulted in accelerated soil erosion, a supra-optimal soil temperature regime of 4 – 6 hours a day, a rapid deterioration of soil organic matter status, nutrient and available water retention capacity of the soil.

Low productivity, traditional agricultural systems, based on bush fallow rotation are still practiced in many areas. Bush fallow is a fairly stable system sustaining small population as long as the fallow period following cultivation is sufficient for soil fertility to be effectively restored. When population density is high, the length of the fallow is drastically shortened, soil fertility declines, and soil stability is lost. The result is a loss in the basic natural resource and low productivity potential. This again intensifies the quest for more land, which has not been available since the mid-1970s, for the government has taken measures to prevent conversion from forest to planted area.

Large-scale mechanized farms and semi-mechanized farming which follows have met with modest success. One of the reasons for their limited success is inadequate attention to the problem of soil conservation and management. In crop production, as opposed to the initial clearing of natural vegetation, additional working of the soil is carried out for a variety of reasons. In most cases, this produces yet further unfavorable changes in the soil which are added to those resulting from higher exposure of the soil surface, as in clearing. The objectives of seed bed preparation are to optimize soil temperature and moisture conditions; minimize weed competition; and stimulate root proliferation and development of seedlings. Although preparatory cultivation generally helps increase the infiltration and percolation of water except where surface horizons. are loose and have excellent structure, this effect is usually transitory. In the long run all forms of cultivation tend to aid the rainfall in breaking down aggregates, sealing the surface, and increasing runoff.

The beginning of the growing season following a dry season is generally hot and dry with supra-optimal soil temperature regime. Tropical rains are intense with high energy load and cause severe erosion, particularly when soil is freshly plowed with little or no residue to cover the surface and protect it from direct raindrop impact.

Exposed soils rapidly lose their productivity capacity; organic matter decomposes fast, nutrients leach away, soil compacts, and populations of weeds, pests, and diseases build up constantly because there is no cold season and only a relatively short dry season to kill them. Physical deterioration characteristics of soil crusting, compaction, and consequent adverse soil moisture regime due to excessive cultivation involving soil disturbance are prominent in many upland cultivation areas.

Up-and-down-hill cultivation is another common practice; a practice that causes accelerated loss of fertility due to erosion and leaching. Cassava cultivation in undulating terrain with 5 – 9% slope in the relatively dry southeastern province has resulted in a soil loss of up to 67 ton/ha/year (Rimvanich, 1979).

In modern agriculture the aim is often a permanent system of monocropping in which it is expected that yield will remain high over extended periods. Under these conditions, the soil is used in such a manner that high levels of natural fertility cannot be maintained. Monocropping without fertilization as practiced in many areas becomes more damaging particularly with the availability of high yielding varieties which remove from the soil a greater amount of nutrients, and soil exposure with subsequent decrease in the level of organic matter is unavoidable. Cassava, maize, and sugar cane nutrient uptake levels are shown in Fig. 1. Comparison of these figures on a monthly basis reveals that maize is the prime remover of plant nutrients.

Also, in most cases, the accelerated loss of nutrients from erosion and leaching following the

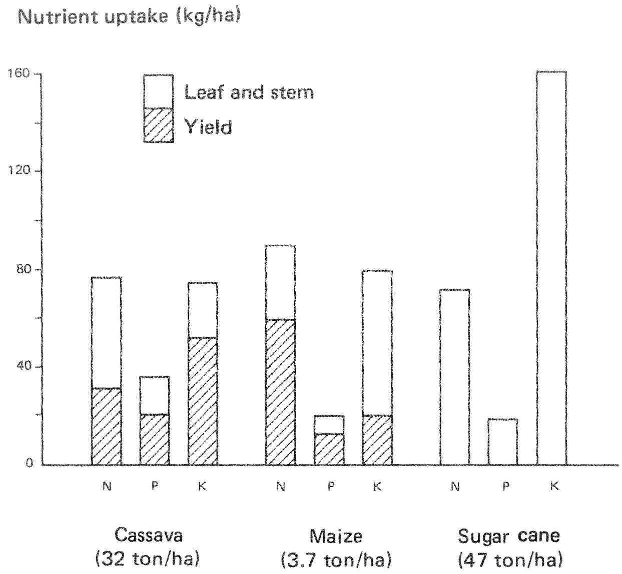

Fig. 1 Nutrient uptake of cassava, maize and sugar cane.
(Uptake data of cassava were secured from samplings of cassava root, stem and leaf from 18 farmers' fields in 1977. Data on maize and sugar cane were obtained from experiments in 1971. Yields corresponding to amount of nutrient-uptake were indicated in brackets.).

removal of organic matter results in declining yields even sooner than would occur from crop removal alone. Each harvesting of crops from the land involves removing some of the nutrients stored in the soil. Long-term effects of monocropping without fertilizer application were demonstrated by a compilation of cassava yield between 1955 – 1971 (Sittibusaya and Kurmarohita, 1978) as shown in Fig. 2. The results showed a deterioration rate equivalent to 0.5 – 1.0 ton of cassava yield / ha / year in the sandy soil of a southeastern province. This exponentially observed deterioration trend also suggested a minimum cassava yield of 6 – 13 ton/ha which an infertile sandy soil can support for quite a long period of time under these cultivation conditions – a subsistence level yield unsuitable for the present-day socio-economic situation.

Dangerous decrease in forested land plus the mounting population pressure makes it imperative that the existing cultivated land be used to its fullest potential. Development of more stable forms of land use which preserve and increase production capacity is urgently needed.

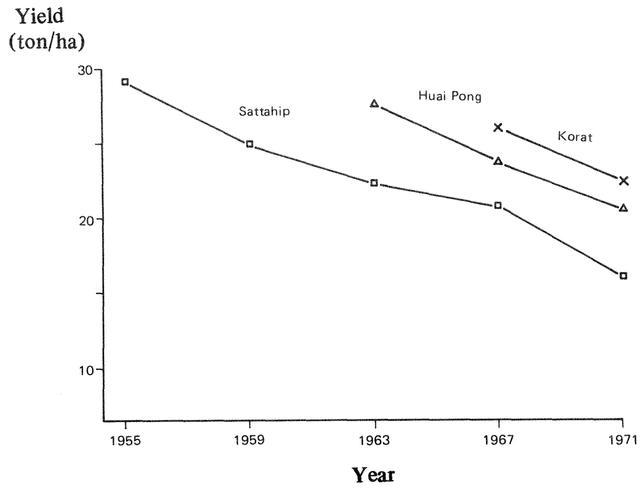

Fig. 2 **Yields of cassava from unfertilized plots of field experimentations since 1955 to 1971 showing the decline in soil fertility.**

Upland soil improvement

Problems associated with upland cultivation in Thailand are many. The most conspicuous one is under-utilization of the land, for on the average only 72% is cropped. The second problem is the low cropping intensity, generally only a single crop in the rainy season. In turn this leads to unemployment in the dry season and to seasonal migration – a feature not common in regions of settled agriculture. The third problem is low yields of crops due mostly to the uncertainty of weather and declining soil fertility. These problems, or a combination of these problems, are present in every region, differing only in the extent of the effects on the socio-economic status.

The single most important cause is the uncertain weather and associated risks which manifest themselves in low and unstable production under rainfed conditions. The second cause is in the light of poor soil fertility – which results from poor soil conservation and management, inadequate use of fertilizer in particular – which, in turn, aggravates the effect of a given moisture stress and makes many areas drought prone. The third cause is the price instability and marketing problem of the important cash crops. The last is beyond the scope of this paper.

Development of stable forms of land use methods for range of soils and ecological zones will have to be a gradual transformation through step-by-step improvements of the existing farming systems. The most obvious remedy is to first minimize the weather risks to mitigate the adverse effect of interspells (moisture stress).

Irrigation is, of course, the best remedy. However, in some regions the water available is limited; large-scale irrigation projects are expensive with long gestation periods; and often the silting of reservoirs becomes evident even before the entire command area is developed. Experience of irrigation in the Central Plain shows that irrigation during the rainy season is not as productive as in the dry season and that the water available for irrigation in the dry season is far less.

There is apparently a larger scope for developing surface and sub-surface water by storing runoff. For a region receiving a mean annual rainfall of 1200 – 1500 mm rainfall, the available runoff would be of the order of 25 to 30%. At the moment, runoff recycling is only a possibility; much research remains to be done to make it a reality. Even then the water will be available only for supplemental irrigation – for critical operations and at critical stages of growth for the crop-life saving.

Another indirect remedial measure under governmental promotion is the use of *engineering soil and water conservation systems* to sustain agricultural production in the uplands mainly in the North. Terracing and contour bunding with graded channels are efficient mechanical methods of preventing soil erosion. If tillage operation is also performed on the contour and a strip cropping system is applied, the greatest erosion control efficiency can be achieved. These methods all function to reduce the catchment distance and direct excess rain water laterally, allowing longer contact with the soil, which results in greater infiltration, less runoff, and thus less erosion. A simple concept but it requires some engineering knowhow in order to construct and maintain properly the system.

However, enforced use of these engineering systems for erosion control by the state is impossible because the farmers could not envisage the usefulness of these expensive techniques which have returns that are uncertain, at best. In addition to high initial capital input, regular maintenance of the terrace-channel system is essential. If the system fails, either due to poor construction or inadequate maintenance, soil erosion can be more serious than with no system at all.

Fertilizer application. Chemical fertilizers are easy to handle and produce quick results. To maintain and improve agricultural productivity without the use of fertilizer would be difficult, if not impossible. An experiment conducted on the sandy soil of a southeastern province which had been under continuous cassava cultivation for over 20 years without any use of fertilizer showed that 373 kg N-P_2O_5-K_2O/ha was required to raise the yield to 42-45 ton of fresh root/ha – the normal yield level when the land was first cultivated. Farmers could have maintained the yield with a yearly fertilizer application of only 18 to 65 kg N-P_2O_5-K_2O/ha (Sittibusaya and Kurmarohita, 1979).

Fertilizer trials and experiments with upland economic crops showed that the majority of responses were mainly to nitrogen and/or phosphate application and relatively few to potassium and only in the sandy soils. Minor and trace element deficiency is usually insignificant or not severe enough for any corrective measures to be profitable. Sulfur deficiency can generally be adequately supplemented with the use of ammonium sulfate as the source for nitrogeneous fertilizer. Zinc deficiency is found only in calcareous soils and only when high dosage phosphate fertilizer is applied.

The majority of upland soils are acidic in reaction. The extent to which low pH affects the nutrient availability and microbial activities varies widely among soils. Liming experiments show that the effects depend upon the soil fertility status–primarily the organic matter and active clay contents – and the nature and degree of acidity. Lime requirement curves were very different among soil groups (Igarashi *et al.,* 1980). Liming is generally recommended whenever possible for all poor fertility acidic soils in order to improve the fertilizer efficiency and/or increase the crops yield potential.

The efficacy of chemical fertilizer, however, does not diminish the usefulness – and generally unrecognized potential – of organic fertilizers. Nevertheless, until recently, the use of organic fertilizers in agriculture had decreased drastically as chemical fertilizer became more available. The rising costs and long-term effects associated with the application of chemical fertilizers make it increasingly important to reexamine the use of organic fertilizers – compost, animal manure, and green manure crops in particular.

Animal manure. Farmyard manure produces quick results but requires bulk application and the effects are generally not long lasting under the high temperature and tropical rainfall environment. Approximately 25 ton/ha of chicken manure was required to produce the same level yield of sorghum as 60-60-60 kg N-P_2O_5-K_2O/ha fertilizer application in a relatively infertile clay loam. The residual effects decreased by half in the second year, and totally by the third year. On the other hand, incremental input of 6 ton/ha/year of chicken manure produced acceptable yield but never reached the level of that with recommended application of fertilizer, except in a year of moderate moisture stress. Optimum yields were obtained by supplementing farmyard manure with chemical fertilizer. Prohibitive costs particularly of transportation and application of the bulky farmyard manure and its adulteration make it unprofitable and impractical to use in large-scale field crop production. At present, animal manuring is limited to small farms (mostly orchards), localized only around some livestock farming centers which give away animal manure.

Municipal compost and farm compost. Composts produce longer lasting results but increase fertility to a lesser degree than farmyard manure. There is implicit evidence that the effects on soil are both physical and chemical–better soil tilth, moisture retention characteristics, and fertility are generally reported in long-term experiments although no direct measurements can be made. Optimum yields are generally obtained by supplementing compost with chemical fertilizers. Long-term experiment from 1963–1969 on cassava grown on a sandy soil of a southeastern province showed that with the application of 25 ton/ha of municipal compost plus 25-25-12.5 kg N-P_2O_5-K_2O/ha/year, the soil fertility status as indicated by yield of cassava can be maintained at the highest level.

Application of compost in addition to liming is also the most effective Al-toxicity control measure for soils of very acid reaction found in the north and north-central plain regions (A summarized report of organic fertilizer research on field crops, 1980). One limitation of the use of municipal compost in the farming areas is the cost of transportation. Farm compost is limited to cash crops of high value such as vegetables and fruit crops.

Soil ameliorating crops and cover crops. Simultaneous cultivation of beans and maize, or rotational cropping of beans and cotton, rice and beans, etc. is an ancient and well established practice in the northern region. Farmers already know that the bean plant helps maintain the high yield of other crops, and they get the beans as a bonus. In humid peninsular and southeastern regions where rainfalls of 20 cm per hour are frequent and more soil gouged out by falling rain-drops than by runoff water, rubber planters know the value of leguminous creepers – in particular *Pueraria phaseolides, Calopognium mucunoides,* and *Centrosema pubescens* – in their capacity as cover crops. Relatively few planters, however, would know that not only do these densely growing leguminous plants shield the soil surface from erosion but also provide nitrogen and humus for improvement of the soil fertility.

The fragile farming ecological situation particularly in upland field crops production, makes it important to expand the utilization of legumes in the cropping system and/or as a soil management measure. Leguminous candidates under investigation include species of *Cajanus, Canavalia, Crotalaria, Desmodium, Erythrina,* Lablab, *Leucaena, Lupinus, Mucuna, Pueraria, Sesbania,* and *Tephrosia.*

Legume foliage with high nitrogen content decomposes quite rapidly compared to grasses after incorporation into soil; generally no sizeable residue can be seen after a period of 6 – 8 weeks. Their physical and chemical effects on soil however long lasting can not be immediately visualized by the farmer. Generally farmers would not consider green manuring because there is no immediate by-product that they can benefit from.

Another disadvantage is that most of the legumes available for use as cover crops are not completely drought tolerant; they can not survive the long summer fallow season. The residue left on the soil surface is a potential fire hazard, although the dead legumes have a good mulching effect.

Mulching. Experiments showed that better moisture conservation is achieved by mulching (Kubota *et al.,* 1979). Decreased runoff losses and the reduction in the first and second stage evaporation by the residue mulch increases the duration of available water by a few days, the exact length of the period depending on soil characteristics. Mulching is already a widespread practice in the North and probably one of the main reasons for the high productive capacity of that region. However, straw and other materials for mulching are generally unavailable at times especially at the beginning of the rainy season. This scarcity of mulching material in combination with the labor required for transporting and spreading the mulch is the main limitation of this practice. Moreover, immobilization of nitrogen in the decomposition process of these wide C/N ratio materials can be quite severe. At present, mulching is generally limited to vegetable and fruit crops production.

If any conclusion can be drawn from the foregoing discussion it is that any effective remedy that would be applicable on a large-scale must take into consideration two factors: better soil and moisture conservation and fertility improvement through both chemical and organic fertilizers. More research emphasis has, therefore, been placed on the cropping system with minimum disturbance of the soil surface, keeping continuous ground cover, replenishing nitrogen by leguminous crops, and maintaining soil structure through natural agencies such as earthworms.

Minimum tillage. The trend of increasing costs for tillage due to higher fuel cost makes weed control by herbicides a more compatible practice. No-tillage with straw mulching is an ancient practice for vegetable crop production in the loamy soils of the North.

Experiments showed that in clay loam soils it is feasible to raise corn under no-tillage culture. (Tongyai *et al.,* 1981). Untilled soil with killed-sod covers shows the superiority of no-tillage culture in moisture conservation characteristics–higher infiltration rate and 2–3 fold reduction in evaporation. For short-term drought stress of approximately 20 days, the no-tillage system is superior to the conventional plowing system. If the drought persists for a long period of time, however, there is no significant advantage. This system also enables greater efficiency of fertilizer application by broadcasting. If minimum tillage becomes a more widespred practice in the future, fertilizer use will probably need evaluation. The improved soil moisture and the no-delay period involved make possible successful second cropping of a legume–which in turn gradually improves the soil fertility status.

The high infiltration rate and favorable soil structure due to mulch and earthworm activity in no-tillage can minimize the runoff and erosion (Kubota *et al.,* 1979). The no-tillage system as an erosion preventive technique can be more attractive to small holders and shifting cultivators than the expensive and difficult-to-install engineering control systems.

At present, minimum tillage for upland crops production is only in the experimental stage. Many problems associated with weeds, pests, and fire need to be ironed out. However, it is the most promising practice available at the moment.

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