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Techniques and Strategies to Ameliorate Salt-Affected Lands in Northeast Thailand

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Abstract

Salinization is common in Northeast Thailand and it hampers the activities of farmers. Characteristics and countermeasures are described at 2 levels: local and watershed levels. In the latter, salinization is controlled based on topography, geological strata and groundwater. In the former, salinization is closely related to the movement of water in and on the soil. Cheap, simple, effective and economical countermeasures including "core techniques" at the local level were developed for the farmers. A countermeasure with long-lasting effects at the watershed level was proposed to the government for completing the amelioration in cooperation with the farmers.

Discipline: Soils, fertilizers and plant nutrition
Additional key words: core techniques, eucalyptus, nam dun, rhodes grass, salt parch

Introduction

Salinization is rather common in Northeast Thailand and has hampered the activities of the farmers who are very poor due to both the water shortage and the low soil fertility. Owing to population pressure, they cleared forests for expanding arable land, especially paddy fields, leading to enhanced salinization. Accordingly, several national and international projects have been conducted to address these problems without remarkable success.

We considered that at first detailed information about the natural conditions, the nature of salt-affected lands and the mechanism of salinization should be acquired at 2 levels (local and watershed levels) in Northeast Thailand. Thereafter, ameliorative techniques could be proposed to both the farmers and the government.

Natural conditions

Northeast Thailand is a square-shaped plateau under tropical monsoon climate with marked alternation of rainy season and dry season (Fig. 1)[2]. The plateau is almost completely surrounded by mountain ranges which intercept southeasterly rain-laden wind in the rainy season, resulting in dry conditions even in the rainy season (Fig. 2)[2].

Salt-affected lands are distributed inside the Korat and Sakon Nakon basins, which are underlain by the Mahasarakham formation containing rock salt strata. The surrounding mountain ranges consist mostly of salt-free geological formations older than the Mahasarakham formation. Geomorphologically, the basins are divided into hilly, undulating and low-lying flat regions from the mountain ranges downward. In these regions, so-called high, middle and low terraces are recognized and *nam duns* (small mounds, formed by the gushing of salty clay mud from below) are present in the salt-affected lands, especially in the undulating region[1].

The vertical profile shown in Fig. 3[2] is common to the basins except for flood plains of large rivers in the low-lying flat region where a sandy layer overlies a thick clay sediment, probably due to erosion and sedimentation in the past. The bed rock is an uppermost member of the Mahasarakham formation. The pallid and the mottled zones correspond to a weathering zone of the bed rock.

Shallow unconfined groundwater and deep semi-confined groundwater (artesian water) flow through

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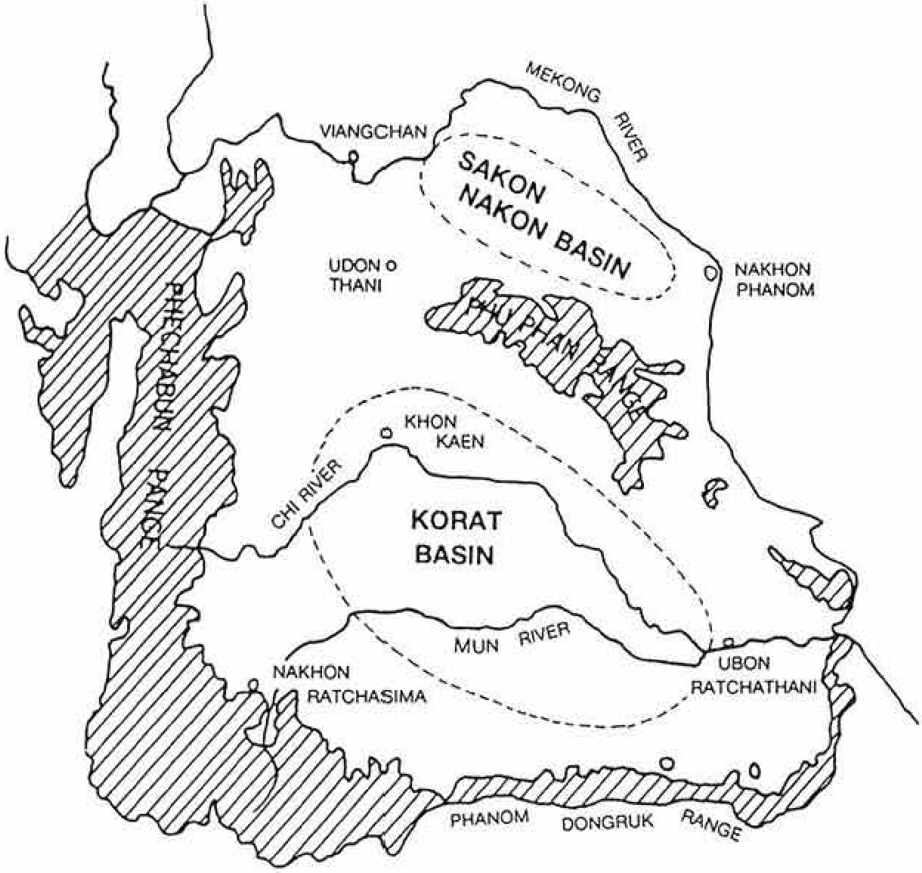

Fig. 1. Physiography of Northeast Thailand[2)]

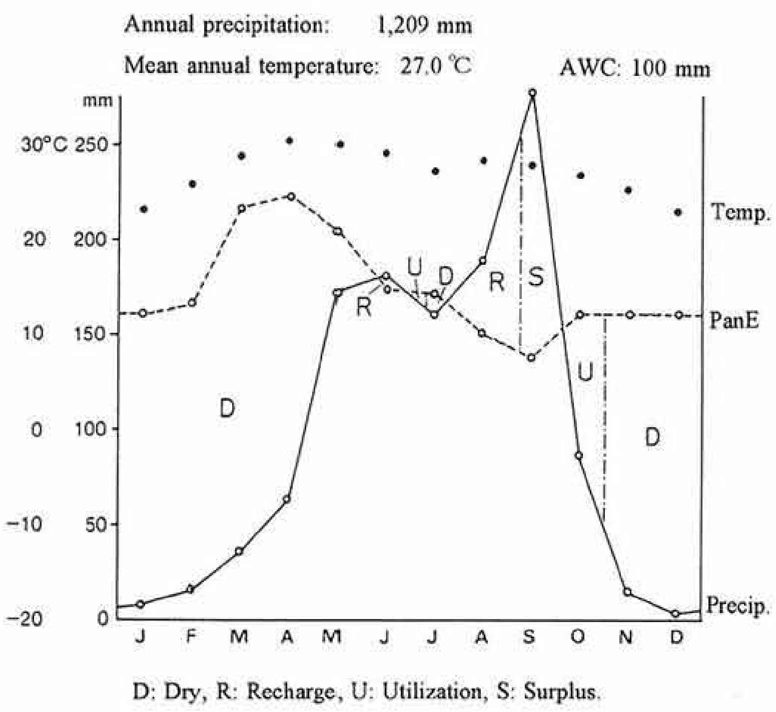

Fig. 2. Moisture regime of Khon Kaen Province in Northeast Thailand[2)]

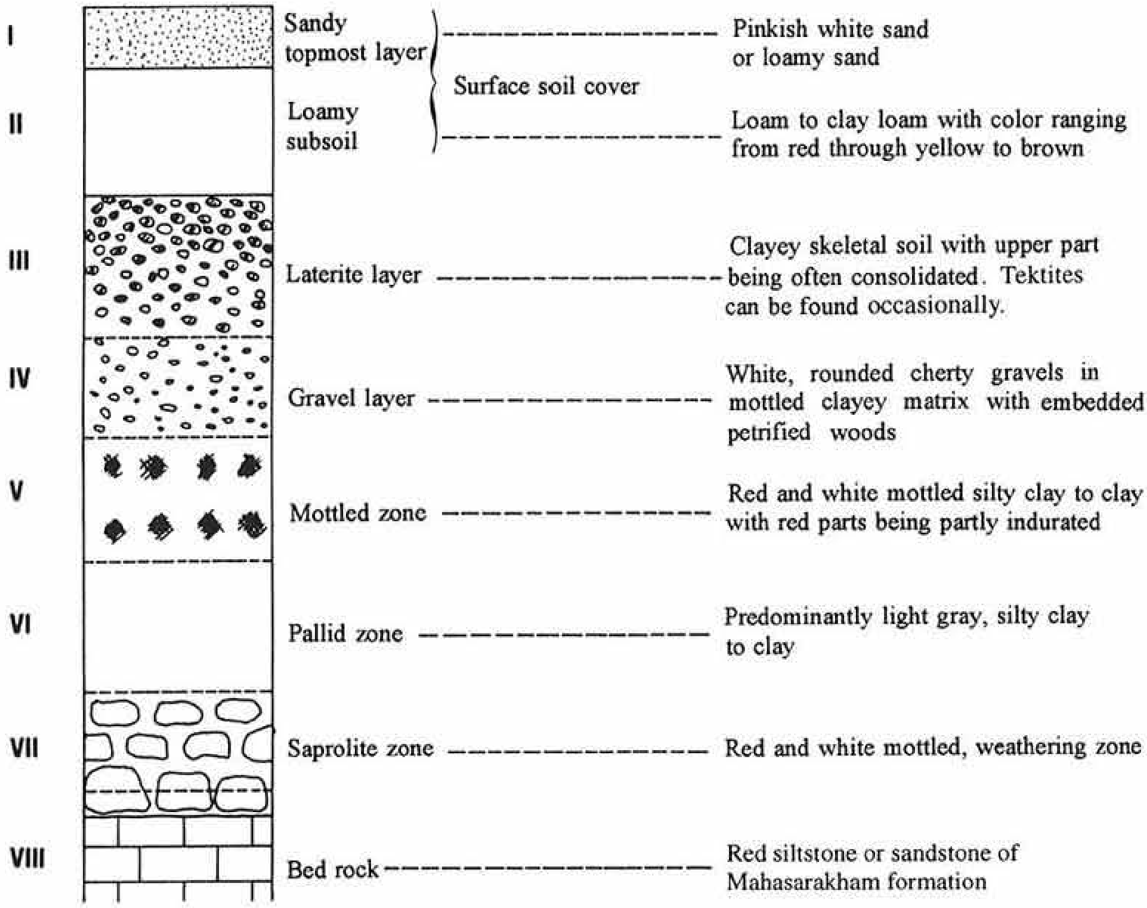

Fig. 3. Generalized upland soil stratigraphy in the Korat basin of Northeast Thailand[2)]

the laterite-gravel layers and the saprolite zone, respectively[1,7)].

Salt-affected lands

The salt-affected lands are classified into strongly, moderately and slightly affected lands[1,7)]. The strongly affected lands are almost bare and snow-white in the dry season due to precipitation of salt on the ground surface. The moderately to slightly salt-affected lands appear as a mosaic consisting of vegetated and bare patches (salt patches).

In the undulating region, one of the causes of salt patches is the presence of an impermeable layer, which is enriched with organic matter as well as with clay and is very close to the ground surface[1,5,7)]. The impermeable layer retains salt and is strongly reduced in the rainy season. No native weeds can tolerate both high salinity and strong reductive state, resulting in salt patches. In the vegetated patches, the impermeable layer is covered with a sandy layer more than about 5 cm thick.

In general, the salt-affected lands are larger and less severely affected from the hilly to the low-lying flat regions[7)]. For instance, in the hilly region, strongly salt-affected areas occur as patches at low elevations. In the undulating region, the strongly to moderately salt-affected areas spread on slopes of the middle terraces from the middle parts downward. Sometimes, many *nam duns* stand along the upper border of the salt-affected area on the slope. In the alluvial plains of the low-lying flat region, which are almost solely utilized for paddy cultivation, the paddy fields are frequently dotted with salt patches[1,7)].

Salinization at watershed level

The process of salinization in the Korat basin is illustrated in Fig. 4[1,5)]. Rainwater falling on the mountain ranges flows down through a fracture zone developed between the Mahasarakham formation and an older formation (Khok Kruat formation) until the rock salt stratum and becomes very saline. The saline water arises through another fracture zone developed between the hilly and the undulating regions to supply salt to the deep groundwater which extends almost all over the basin. In addition, it rises through cracks in the overlying clay layers toward the ground surface, supplying salt to either the shallow groundwater or to the ground surface resulting in *nam duns*, if the pressure of the deep groundwater is sufficiently high. This process implies that salt supply from the deep groundwater occurs mainly in the undulating region, especially in the middle parts of the slope of the middle terrace.

The salt supplied to the shallow groundwater or to the soil moves further upward inside the soil with rising capillary water.

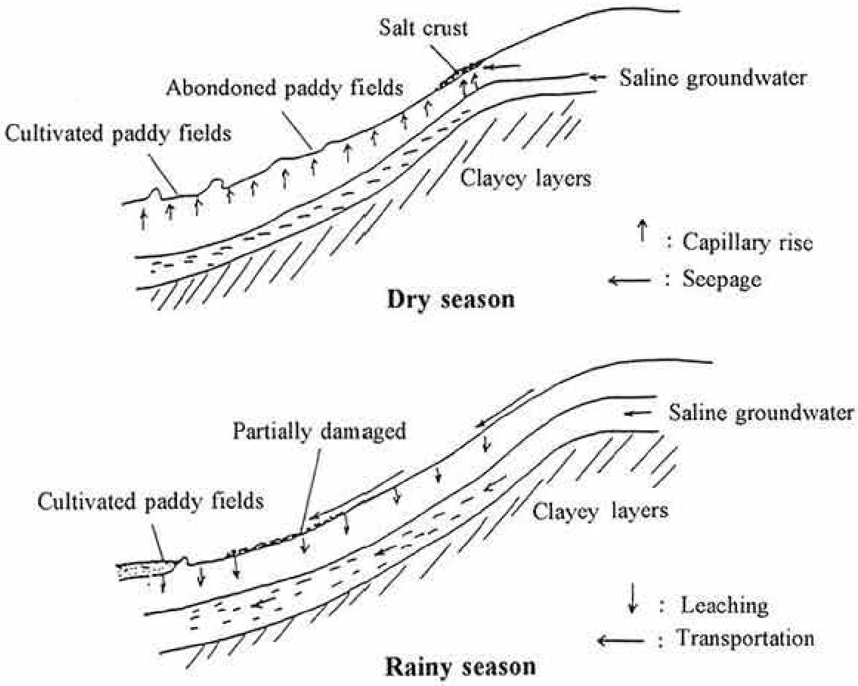

Fig. 4. Two-step process of salinization on a slope of the middle terrace[1,5)]

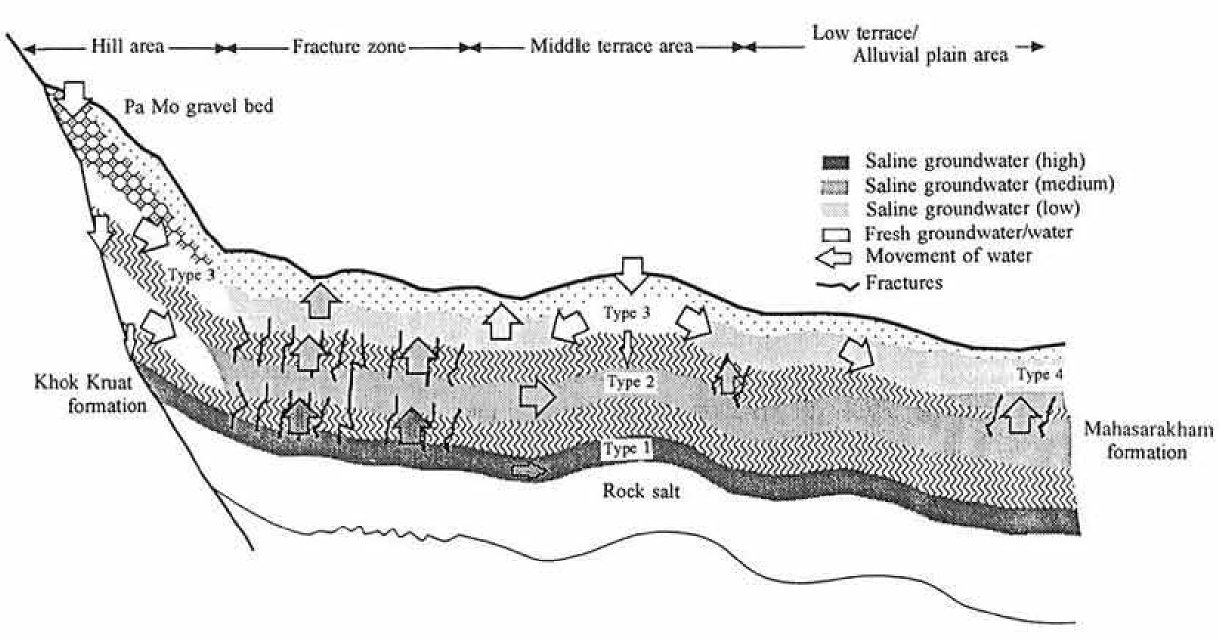

Fig. 5. Salinization in the watershed (western part of the Korat basin)[1,5)]

Plate 1. Abandoned paddy fields due to salinization
Salty mud flows down from the salt-affected slope.

Plate 2. Vigorous growth of rhodes grass on a salt path ameliorated by "core technique"

Salinization at local level

1) Undulating region

The salt accumulated on and around the ground surface in the dry season is transported downward together with soil particles by runoff water (erosion) (Fig. 5)[1,5]. The paddy fields on the footslopes are salinized by intrusion of the salty mud flowing down from the slope through destroyed borders (Plate 1). The impermeable layer described above promotes the lateral extension of the salt-affected area by inhibiting desalinization with percolating water and by enhancing the erosion. Salinization in the hilly region is similar to that in the undulating region.

2) Low-lying flat region

In the dry season, salt accumulates in the surface sandy layer, especially in the salt patches where the surface sandy layer is thin, being supplied from the underlying clay layer containing salt[1,7]. The accumulated salt in the surface layer is laterally transported through flood water in the rainy season.

Ameliorative techniques at local level

The ameliorative techniques at the local level were developed for the farmers. These techniques should be simple, economical and effective for the farmers.

1) Selection of plants

Suitable plants included rhodes grass (*Chloris gayana*), *Sesbania rostrata*, *S. cannabina*, *Panicum repens*, *Eucalyptus camaldulensis*, etc.[1,4]. Rhodes grass is especially suitable as it grows very fast from the seeds sown on the ground surface in the rainy season and produces a large biomass if the seeds are protected against erosion. The grass expands its territory through runners, remains green in the dry season and is used as feed for cattle by the farmers all the year round.

2) Amelioration of the salt-affected areas on the slope

Essential requirements of the ameliorative techniques are as follows: (1) to suppress the accumulation of salt with rising capillary water, (2) to suppress the downward transport of salt due to erosion, (3) to promote desalinization with percolating water, (4) to protect the sown seeds against erosion, and (5) to promote root elongation into subsoils with low salt content[1,4,6,7]. Effective treatments included mulching with rice husks (for (1)), destruction of the impermeable layer by plowing (for (2), (3)), application of cow dung (for (5)) and insertion of frames made of bamboo coops (for (2), (3) and (4)). These treatments can be readily combined according to the nature of salinization. The techniques including varying combinations of these treatments are collectively called "core techniques". For instance, the combination of all 4 treatments enabled rhodes grass to grow vigorously even in the salt patches of the moderately to strongly salt-affected areas where the groundwater table is not too high (Plate 2).

3) Amelioration of salt-affected paddy fields on the footslope

It is essential to repair or reconstruct the destroyed borders for ameliorating the paddy fields by preventing the intrusion of the salty mud, even though borders made of saline sandy soil are likely to be broken. The borders could be reinforced by putting plates inside the borders. Thus, rice could grow in the salt-affected paddy fields[1,7].

4) Management of salt-affected slope

Since ameliorative techniques in each part of a salt-affected slope are interrelated with each other, comprehensive slope management is necessary (Fig. 6)[1,7].

A forest consisting of salt-tolerant trees (e.g. *E. camaldulensis*) with high potential for evaporation should be established in the upper boundary of strongly salt-affected areas where salt is supplied from the deep groundwater. This forest plays several roles as follows: (1) decrease of the downward transport of salt by erosion, (2) decrease of level of shallow groundwater on the slope, and (3) decrease of the pressure of deep groundwater.

The strongly to moderately salt-affected areas in the middle to lower parts of the slope can be ameliorated by "core techniques".

The paddy fields on the footslope are ameliorated by constructing resistant borders. To further enhance growth and increase yield of rice, the following cultivation techniques should be utilized: (1) mulching with rice husks from the dry season, (2) application of green manure by cultivating sesbania before rice seedlings are transplanted, (3) plowing under sesbania debris 1 week after placement on the ground surface, and (4) enclosing salt patches with simple borders. These treatments were found to be effective in the low-lying flat region[3].

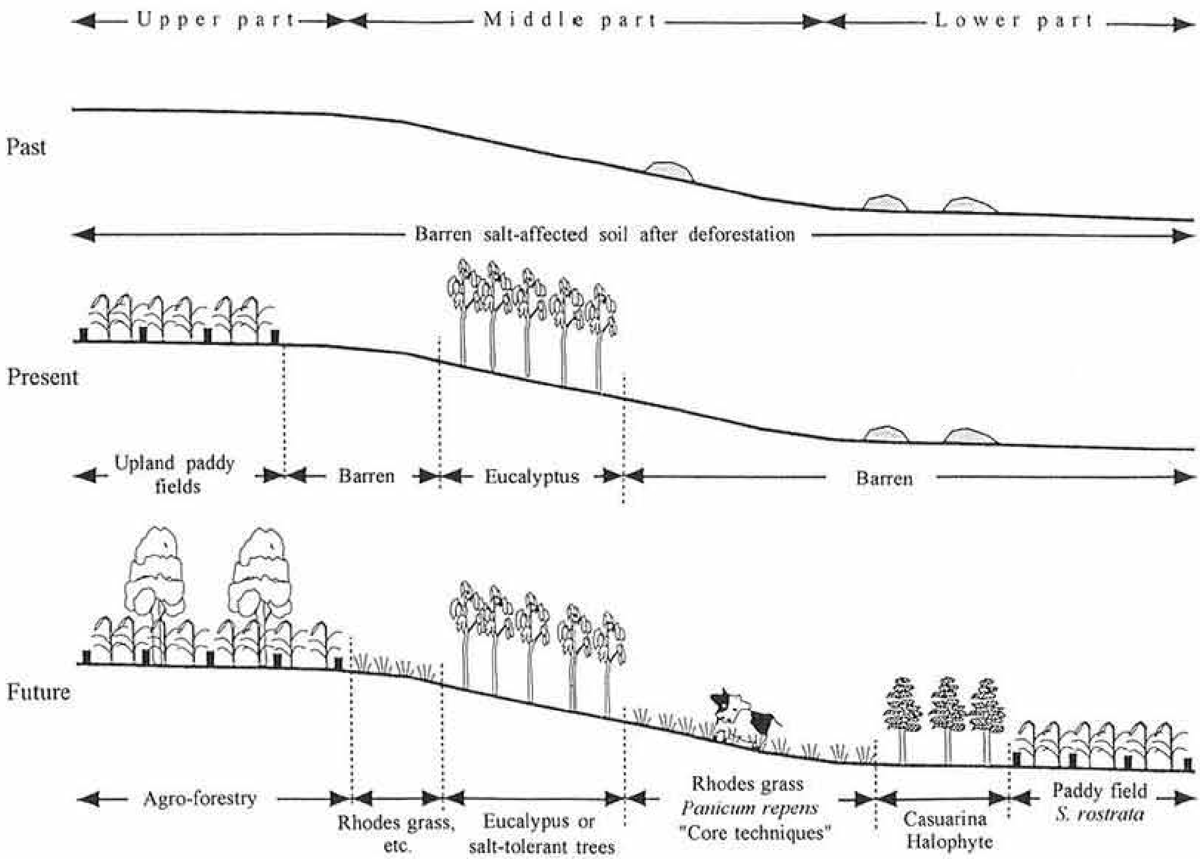

Fig. 6. Comprehensive management of a salt-affected slope in a middle terrace[1,7]

Ameliorative techniques at watershed level

Reforestation of the upper boundaries of the salt-affected areas on all the slopes in a watershed should be promoted and implemented by the government[1,7], because (1) a few farmers support reforestation policies, (2) the forest zone of the farmers is small in size, incomplete and fragmentary, and (3) complete reforestation is expensive and difficult, though it exerts a wide range of ameliorative effects over a long period of time.

References

1) Kohyama, K. & Subhasaram, T. (eds.) (1993): Salt-affected soils in Northeast Thailand; Their salinization and amelioration. Technical paper No. 12. Agricultural Development Research Center in Northeast Thailand (ADRC), Khon Kaen, Thailand.
2) Mitsuchi, M., Wichaidit, P. & Jeungnijnirund, S. (1986): Outline of soils of the Northeast Plateau, Thailand; Their characterization and constraints. Technical paper No. 1. ADRC, Khon Kaen, Thailand.
3) Nagase, K. (1992): Improvement of salt injured paddy field in Tung Kula Rong Hai Northeast Thailand. *In* Proc. Int. Symp. on Strategies for Utilizing Salt Affected Lands, 1992. Bangkok, Thailand, 519-531.
4) Puengpan, N., Subhasaram, T. & Wada, H. (1992): Cultivation of eucalyptus and rhodes grass at the salt-affected areas in Northeast Thailand. *In* Proc. Int. Symp. on Strategies for Utilizing Salt Affected Lands, 1992. Bangkok, Thailand, 457-465.
5) Puengpan, N. et al. (1992): Characteristics of salt affected soils in Northeast Thailand with special reference to soil-plant relationships. *In* Proc. Int. Symp. on Strategies for Utilizing Salt Affected Lands, 1992. Bangkok, Thailand, 97-105.
6) Subhasaram, T., Puengpan, N. & Wada, H. (1992): Simple and effective techniques to suppress salinization and to cultivate plants in moderately to strongly salt affected areas in northeast. *In* Proc. Int. Symp. on Strategies for Utilizing Salt Affected Lands, 1992. Bangkok, Thailand, 232-240.
7) Wada, H., Wichaidit, P. & Pramojanee, P. (1994): Salt-affected area in Northeast Thailand; Nature, properties and management. Technical paper No.15. ADRC, Khon Kaen, Thailand.

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