Applications of remote sensing to California rice production and marketing

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Climatic conditions and different cultural practices make it difficult to assess foreign rice acreage by remote sensing.

In an effort to obtain global crop information, considerable time and money have been spent on developing technical models for using remote sensing from the earth resources satellite Landsat. Remote sensing experts expect that once global distribution of agricultural land by crop type has been mapped, year-to-year changes in acreage of a particular crop can be observed and will signal any developing shortage or surplus. If estimates indicate a production anomaly, government officials hope that there will be sufficient time for offsetting measures, such as altering the domestic production of that crop or reallocating U.S. reserves.

Two assumptions implicit in this proposition deserve further attention. The first is that Landsat will significantly improve our ability to recognize shortages or surpluses as they develop overseas. The second is that U.S. farmers will voluntarily adjust production when faced with the type of information that Landsat is capable of providing. This study of rice production in California was designed primarily to investigate the second assumption and to examine the effect, real or imagined, that Landsat could have on rice marketing, particularly by California-based interests. The conclusions of the study, in which extensive interviews were conducted with 30 rice growers, managers of three large rice cooperatives, and several private commercial operators, suggest that, although *production* adjustments would probably not occur, Landsat might well provide important information for rice *marketing* interests.

Spectral characteristics of rice

Remote sensing in agriculture uses the principle that every natural or manmade feature on earth reflects radiant energy in distinctive amounts at specific wavelengths. Remote sensing experts have identified the "spectral signatures" of certain crops and can use this signature to distinguish a crop from its surroundings.

Rice was chosen for this study, because its temporal and spectral characteristics are so different from all other crops in rice-growing areas that separating it from other vegetation is relatively simple. Total rice acreage may be evaluated by summing all plots of land that reflect the signature identified with rice. Minor discolorations of the signature can aid in identifying stressed and damaged crops. Yield estimates can then be compiled by multiplying total rice acreage by the average yield per acre and subtracting the damaged crop.

Limitations

Satellite remote sensing techniques have some major limitations, however, in estimating rice acreage and projected yields. Acreage may not always be a good indication of yield. Different rice varieties may account for as much as 10-bag-per-acre variation in yield. Within the same variety, differences in soil, water depth, fertilizer timing and rate, and wind velocity may also make a 10-bag-per-acre difference, even if all the rice is heading at the same time.

Rice blanking, in which the crop appears healthy but has a high proportion of unfilled heads, also causes ambiguity in yield estimation. In this case, acreage estimates would give incorrect data if they were based on historical yield models. This difficulty might be overcome by taking sample head counts, which could theoretically be worked into a variable yield model to account for the year-to-year fluctuation. Where sample collection is not possible, as in countries like North Korea where we do not have diplomatic relations, this could be a matter of concern.

These problems are compounded in the case of foreign acreage, because current methods of estimating acreage with remote sensing are based on techniques developed with large-scale production in mind. In the United States, rice is grown in large plots, usually from 150 to 1,000 acres, but most foreign rice is produced in 1- to 3-acre plots. This small scale and different cultivation techniques, such as terracing on hillsides, make it difficult for Landsat to determine accurately the acreage devoted to rice and the crop condition.

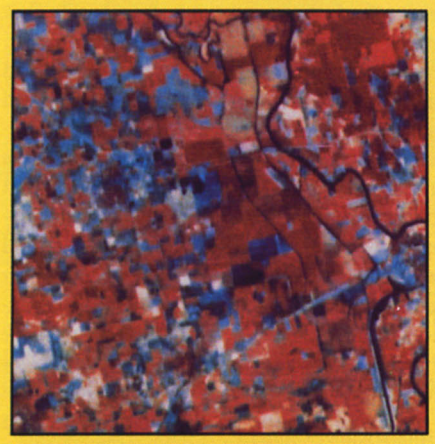
Another problem is that most foreign rice-growing countries, such as Taiwan, Burma, and Thailand, are extremely humid with heavy rainfall. Because satellite remote sensing depends on clear skies for best results, these climatic conditions limit its efficacy.

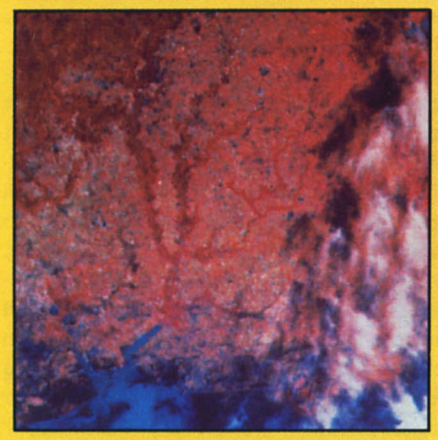
Thus, even with satellite remote sensing, it may be difficult to determine accurately whether surpluses or shortages are developing overseas, or what actual resources are available in countries where we do not have diplomatic relations or access to records. Moreover, if the margin of error in foreign yield projections remains high, despite the addition of sophisticated remote sensing techniques, the real advantages gained over conventional methods of estimation must be carefully evaluated.

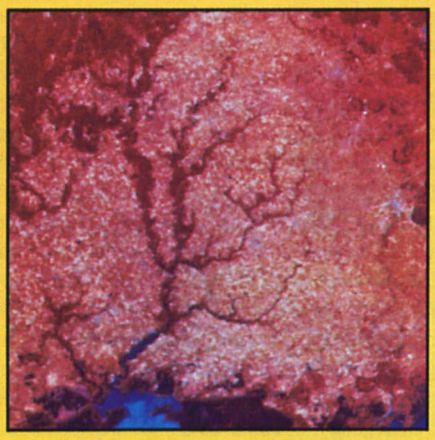
In spite of interest in furthering the use of Landsat to improve the accuracy of U.S. Department of Agriculture (USDA) estimates of rice acreage, most California producers and marketers already receive more accurate information and use a different method of estimation than does the USDA. Thus, the benefits of increased accuracy attributed to satellite remote sensing, as compared with present USDA accuracy, tend to exaggerate the real benefits—especially in California.

Most rice grown in California is marketed through two rice cooperatives and four private commercial operations. The two cooperatives sell 75 percent of the rice in California; the private commercial operations market another 15 percent. All six have regular clientele and depend on a relatively consistent supply of rice from year to year. They have developed very accurate acreage projections based on their clients' planting reports, information from their own fieldmen and agronomists, and their seed sales to their clients.

These cooperatives and private commercial operations share with one another the information gathered through these methods. As a consequence, their chief executive officers were in general agreement in this study that







Landsat color composite images of rice-growing sites (red areas) near (left) Biggs, California, and (below, left and right) Crowley, Louisiana. During the entire 1973 growing season, only two of the many Landsat overpasses of the Louisiana site occurred on sufficiently cloud-free days (lower right) to provide interpretable imagery of fields.

Landsat could not significantly improve on information currently available on California rice acreage.

When it came to information on rice acreage in the southern United States, the country's major rice-growing area, the response was more varied. One executive officer's opinion was that current information on southern rice acreage could be improved upon but that it was not necessary to rely on remote sensing, because less expensive alternatives exist: the acreage estimates have been very accurate in the past when the USDA has judiciously enforced allotment policy. The other executive officers felt that their branch offices in southern rice-growing states already provided accurate estimates, or that accurate estimates were available from other sources.

Production decisions

Even if we assume that the aforementioned technical problems would not interfere with our ability to recognize an impending foreign surplus or shortfall, the limited mobility of farm resources would prevent any significant offsetting action by farmers. Most rice farmers in California have two options with their land—planting winter wheat or planting rice. (Only in the northernmost part of California can both winter and spring wheat be grown.)

Although the wheat alternative theoretically exists, most farmers who can grow rice said they preferred it over wheat, because, while perhaps more risky, rice generally gives a higher return on investment. Therefore, it would probably be difficult to find land now being used for wheat that is suitable for rice. Also, the expected price of rice would probably have to go up considerably before farmers with marginal land would plant rice, and the expected price would have to go down considerably before farmers would decrease current rice acreage. Most rice farmers, moreover, said they would not alter their current crop mix even in response to a short-run change in prices, either because they would not want to break rotation, or because their land was not as well suited to other crops.

What cannot be overemphasized is that, although these concerns severely limit the willingness of the farmers studied to make major production modifications, it is farmers such as these, with a choice between rice and wheat, who are Landsat's target population. Remote sensing experts insist that information produced by Landsat will improve the quality of inputs in deciding between rice and wheat, but the benefits seem exaggerated. Landsat's target population is, at best, a small minority of U.S. rice farmers.

Moreover, it is not altogether clear that the quality of this information can be significantly improved. In fact, if we examine how farmers arrive at their decisions between wheat and rice and, if they choose to plant rice, how they decide how much to plant, a different conclusion seems warranted.

Rice farmers in California must decide by about December 31 of a given year whether to plant wheat or rice, because this is the last day they can plant winter wheat. The choice is based on both the forward price offered for wheat and the farmer's willingness to take a risk on the less sure, but potentially more rewarding, rice. Information gathered by Landsat would play no role in this decision.

A farmer who has chosen to plant rice then must decide by the end of February how much to plant. This decision is based on the size of foreign rice crops harvested before February of that year and weather conditions in foreign countries during the previous December. In December, countries in tropical regions where two rice crops can be produced plant the second crop. Relevant information for both considerations is currently available from conventional sources early enough to be carefully evaluated, and thus Landsat could contribute little pertinent data.

Marketing

Although Landsat information comes too late to alter production, remote sensing may indicate the physical condition of foreign rice crops and major changes in acreage. Such data would be extremely important to California rice producers in marketing and in making price projections. In particular, Landsat could provide to cooperatives and independent marketing agents information that would help balance the superior information on foreign crops presently available only to the multinational grain companies, such as Cargill, Continental, and Cook, through their own highly sophisticated intelligence-gathering networks. California cooperative and commercial management executives questioned were virtually unanimous in their

Landsat color imagery of rice-growing test area near Sutter's Butte, California (circular feature), traces seasonal progress of crop from field flooding through maturity.

view that the information available to multinational grain companies is better than their own and, furthermore, that this advantage is reflected both in the comparative prices they receive for their rice and the frequency with which they miscalculate the world market.

Thus, if Landsat-generated information is disseminated to all rice producers and marketers at the same time, and not leaked earlier to one component of the production and marketing chain, it will tend to counterbalance the market superiority of information the multinational grain companies presently maintain over the less concentrated market of grain sellers. On the other hand, assuming that the multinational companies already have operatives in a foreign country, marketing firms that do not have operatives in that country will be at a comparative disadvantage by the time Landsat data are processed and disseminated. A major technical limitation of information collected from satellite remote sensing is the considerable time lag between processing Landsat data, recognition of the situation, and dissemination of the data. Current estimates place average turnaround time at an optimistic seven to ten days, with a minimum time delay under emergency circumstances of 24 to 48 hours.

Although multinational grain companies and cooperatives already have information-gathering services, Landsat could provide independent producers (individuals who do not market their rice through a cooperative) with a similar benefit by collecting and disseminating information on rice acreage in the United States and in foreign countries. (Whether or not this is a least-cost alternative is another issue.) Not surprisingly, all of the producers queried said that more accurate information on both world rice conditions and domestic acreage estimates would help them in marketing their rice.

While independent producers would seem to be the prime beneficiaries of this new technology, it may be skewed sharply in favor of cooperatives. This brings up the question: how does the market structure in California affect the successful use of information?

With their share of the rice market in California, cooperatives have the incentive to watch carefully any new developments with Landsat. They also have the resources and manpower to help plan future data collection and the optimal use of existing information systems. Cooperative managers did not indicate enthusiasm to pay for the type of information Landsat will produce, but they were interested in participating by sending a representative to the Johnson Space Center once or twice a year to investigate developments and direct research toward specific needs. This type of direct participation would exclude independent producers and would provide benefits for the larger centralized marketing firms.

Cooperatives also are better able to analyze world crop data and make the important marketing decisions. Moreover, because cooperatives have more market experience and can predict more accurately the effects of external and internal variables, their information should, on the whole, be more accurate than the individual's and may lead to better decisions.

Although cooperatives and independent producers may be given the same information, the cooperatives' experience in using the information may lead to decisions considerably different from those of the independents. The independent producer, for example, is not able to gauge as accurately the supply elasticity of rice on the world market: if there is a foreign shortage, he may have little idea as to whether prices will go up 15 or 50 percent. More importantly, unless the individual producer belongs to a private crop service, he will have no independent source for confirmation of a shortage or of its expected effect. As a consequence, he will hesitate to hold out for higher prices.

Conclusion

Thus, although the kind of data that would be forthcoming from remote sensing might not seriously alter production patterns, it could have a considerable effect on marketing. First, if remote sensing technology provides more accurate, up-to-date information on the world rice situation, there could be a greater convergence in the prices that multinational grain companies, cooperatives, and independent producers receive. Second, if the data gathered by remote sensing were not disseminated in a format readily accessible to and understood by organization staff and individual farmer alike, the independent producer might have an incentive to join a cooperative to take advantage of its ability to integrate new information in its centralized marketing structure. Better global forecasts are vital to the United States as the world's largest exporter of food. It remains for those who have the know-how to make knowledge available to the decision-maker.

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