Turkey - Agriculture

1977

Packages of Practices;
A Step at a Time with Clusters?

by

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Paper presented at the joint meetings of the American Agricultural Economics Association and the Western Agricultural Economics Association, San Diego, California, July 31 - August 3, 1977.

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Abstract

Despite increased use of modern technology, few Turkish wheat farmers have adopted the complete recommended package of practices. Reconsidering the package as clusters of practices adopted in an agronomically and economically logical sequence provides a better explanation of farmer behavior and a guide for useful agronomic experimentation and economic analysis.

Packages of Practices; A Step at a Time with Clusters?

Ever since Mexican wheat came to Turkey in 1967, improved wheat technology has been extended to the Turkish farmer using a "package of practices" approach(1). While wheat yield and production has risen impressively in recent years, there is mounting evidence that the farmers are not adopting the improved technology as a package. (Demir, Winkelmann). Therefore, while there may be good reason to continue to organize extension efforts around a package approach(2) there is also value in formulating a model to explain what farmers are actually doing as opposed to what it is recommended they do. Formulating such a model requires multi-disciplinary teamwork between, at the very minimum, agronomists and economists. Such cooperation is often urged but seldom practiced. With the agronomist's training stressing interactions among practices and inputs, he favors the complete package approach. The economist with his emphasis on the scarcity of resources and marginal analysis tends to take a more incremental approach to the adoption of a new technology. As a result of these vastly different viewpoints, casual encounters between economists and agronomists usually end with each deciding that the other has no appreciation of the facts of life as regards the adoption of new technology.

One of the strengths of the recent interdisciplinary approach of the international agricultural research institutes and of projects like the Rockefeller Foundation wheat project in Turkey is that encounters between agronomists and economists are not casual but serious and sustained and directed toward a common developmental objective. Possibilities emerge for a synthesis which can reconcile the economist's urge to view each practice separately and the agronomist's urge to view them strictly as a package. A collaborative effort can define some sensible, operationally significant subsets of the package. In some cases these subsets will be single practices or inputs; in other cases, "clusters" of practices and/or inputs where substantial interactions are expected. By ordering these subsets in an agronomically and economically logical progression, it is then possible to evaluate farmer adoption behavior in terms of this theoretical model; also to design agronomic experiments of manageable size to simulate the farmer's likely decision path. In short, it is hypothesized that farmers tend to adopt new practices in a particular order which can be roughly established in advance by use of agronomic and economic theory.

In the Central Plateau of Turkey bunt poses a serious threat to wheat. Given the large losses which can be incurred should the crop become infected, seed treatment can serve as relatively cheap insurance against serious risk. Viewing the farmer, to use Winkelmann's phrase, as an "income-seeking risk averter", one would expect widespread use of a practice which reduces risk of loss at very low cost. Moreover, because of the long-term educational program on seed treatment by the Turkish Ministry of Agriculture these benefits are generally well-known by the farmer. In view of both the high expected benefit/cost ratio and the widespread knowledge of seed treatment it is hypothesized to be the first practice in the package which a sequentially adopting farmer would use.

Turning to another relatively simple and low cost practice, sketchy but persuasive experimental data suggest that the use of herbicide to curb weed competition can improve yields dramatically even when otherwise traditional practices are used. In a small series of experiments on farmer fields Ms. Nedret Durutan at the Turkish National Wheat Research and Training Center found that applying herbicide to farmers' fields even under primitive levels of technology and thin soils increased yields 67% from 41 kg/da. Even though these yields are extremely low before and after, these results suggest a benefit/cost ratio for the herbicide of over three to one. Other experimental data generated by Hepworth and Tezel for herbicide used with otherwise unimproved practices gave a benefit/cost ratio of 4.4 to one (Mann). In any sequential application of the technology herbicide application probably should come very early in the sequence.

Serious phosphorous deficiency is a charasteristic of the soils of Anatolia. Many years of fertilizer experiments have shown consistently high returns to phosphorous application. (For more detailed discussion and a comprehensive list of references, see Wright.) Therefore as our serially adopting farmer moves up the scale of technological sophistication, his next investment probably should be the application of phosphate fertilizer at time of seeding in the fall. In Anatolia, where grain drills are now fairly widely available, this fertilizer would be normally applied with a grain drill, either owned, rented or borrowed.

The concept of clustering takes on more significance when our sequentially adopting farmer moves the next step up the technological scale. Up to this point, he has protected his wheat against bunt. At low cost he has eliminated weed competiton as a threat to yield; he has removed the constraint of phosphorous deficiency. With these practices he may be approaching the yield ceiling of local improved varieties. If he is to raise yields higher he must increase further available soil moisture. To do this changes in tillage practices are needed. If added moisture can be conserved, another series of interactions are possible between nitrogen, moisture, and fertilizer responsive, high yielding varieties. Thus the final cluster of practices hypothesized is improved (and earlier) tillage for moisture conservation; added nitrogen which can be used effectively with this conserved moisture and high yielding varieties (HYV) which can respond to these high levels of nitrogen.

To summarize the argument to this point, in a serial or sequential adoption of practices, there is reason to believe that a particular ordering and grouping of practices would be logical and expected. These hypothesized steps are: 1) treatment of the seed against bunt, 2) 1+ herbicide use, 3) 1+2+ drill and fall phosphorous application, 4) 1+2+3+ moisture conserving tillage, nitrogen, HYV.

Having described this theoretical framework, let us examine the results of a 1976 survey of a random sample of Ankara province wheat farmers to see to what extent farmers follow such an ordering and grouping in adopting the improved wheat technology. The data used in this paper consist of descriptions of the practices in use on the fields of 158 farmers. The data are arrayed in Table 1 with the practices set out across the top in accordance with the order described above. The table shows percentages of the fields in which the various practices were employed. As was expected a high percentage of the seed was treated (92%), often treated in the village itself by simple methods. The percentage of fields with herbicide use is substantially lower (58%). While lower than fall fertilizer use, this is quite a high percentage, considering that until recently this input was neither widely understood nor widely available. Moreover, in line with the hypothesis that a sequential adopter might use herbicide even before phosphorous fertilizer, it is interesting to note that of the 65 fields with no fall fertilizer 26 (40%) were treated with herbicide.

Looking at the "seeding cluster" 68% of the fields received fertilizer in the fall, the majority of it in the form of triple superphosphate. Confirming the clustering of these two practices, of the fall fertilized fields 87% had the fertilizer applied with a drill; of the fields where the seed was drilled 88% received fall fertilizer.

In the "moisture conservation cluster" the relationships among practices are less strong, although there are patterns more or less conforming to expectations. The most widely used single practice in this cluster is spring nitrogen, applied to 43% of the fields. As noted earlier, this practice depends upon the presence of adequate soil moisture to be effective. In a normal or below normal rainfall

Table 1. Summary of Adoption of Selected Practices in Wheat Production in Ankara Province 1975-76 Crop Year (158 Farmers) /1

			Seeding Cluster		Moisture Conservation Cluster							
	Treated Seed	Herbicide	Fall Fert.	Drill Seed	Plow Early	2nd Tillage yes	2nd Tillage swp/2	3rd Tillage yes	3rd Tillage swp/2	Spr. Fert.	HYV	Tractor all ops.
All Fields (202 Fields)	92%	58%	68%	70%	27%	61%	(40%)	11%	(61%)	43%	12%	65%/3
Spring Fert.(N) (86 Fields)	97%	84%	78%	71%	37%	73%	(48%)	16%	(50%)	100%	20%	63%
Plow Early (55 Fields)	100%	65%	85%	93%	100%	91%	(54%)	25%	(50%)	60%	24%	96%
Swp 2nd Tillage (49 Fields)	98%	47%	88%	94%	59%	100%	(100%)	29%	(50%)	65%	18%	90%
HYV (25 Fields)	100%	84%	92%	100%	56%	92%	(39%)	20%	(60%)	68%	100%	96%
3rd Tillage (23 Fields)	100%	52%	96%	91%	61%	100%	(43%)	100%	(61%)	61%	22%	78%
Complete Package (2 Fields)/4	100%	100%	100%	100%	100%	100%	(100%)	100%	(100%)	100%	100%	100%

/1 Where two or more sets of practices were in use on one farm, data were collected separately for each set and "fields" thus defined having uniform practices. Disregarding irrigated wheat, this left a sample of 202 fields.

/2 Percentage of those doing 2nd or 3rd tillage who use sweep for that operation.

/3 In 90% of the fields first plowing was by tractor.

/4 Disregarding variety and no sweep in secondary tillage 7 fields had complete package.

year this moisture must be assured by improved tillage methods. However, in a good rainfall year there may be enough moisture even with traditional tillage methods for nitrogen to be effective. Farmers may have found the benefits of spring nitrogen to be independent of the rest of the practices of the moisture conservation cluster as they may realize enough benefit in the good years to cover the loss due to wasted nitrogen in the bad. For this reason perhaps spring fertilizer should be considered as a separate "step" coming in sequence between the seeding cluster and the moisture conservation cluster.

Turning to tillage practices, on the basis of the cluster hypothesis it had been expected that selecting fields on the basis of tillage date could serve to separate those using the full package from those not using it. As can be seen from the break-out of early plowed fields, to some extent, this is the case. Early plowed fields do tend to have a higher percentage than late plowed fields of other practices such as fall fertilizer (85% in early, 61% in late); secondary tillage with sweep (49% in early, 15% in late); spring fertilizer (60% in early, 36% in late). Clearly practices on early plowed fields tend to be more improved than those on late plowed fields. However, only 60% of the early plowed fields received spring fertilizer and only 20% were planted with high yielding varieties (defined as Bezostaya or Bolal).

Rather than reflecting some behavioral weakness in the model, these gaps may be the result of problems on the supply side. One expects a farmer both plowing early and using a sweep to know about spring fertilizer and improved varieties. Farmers complained about problems in finding fertilizer in the spring and about late seed delivery in the fall. Accordingly, there is considerable risk in the use of the HYV's not from the point of view of field performance, but timely delivery for planting. (If seed arrived late it was often sold at a large discount by the farmer.)

Since early plowing was not always found linked with all other elements of the package as hypothesized in a strictly serial adoption sequence, the data were "pivoted" about other elements of the moisture conservation cluster in the hope of finding some other element associated with full use of the package. In other words, maybe the only farmers who have it all together are those tilling with sweeps, or those doing three tillages, or those using HYVs. As can be seen from the table, none of these elements produce a row of 100% use of every practice in the package. All things considered, the fields with HYVs come the closest of any category to achieving the complete recommended package. However, as the bottom line shows, there are only two fields where the full package can be found.

The lack of substantial adoption of the complete package does not suggest that the extension effort has failed or that the package is unsuitable. On the contrary, there has been impressive adoption of the leading elements of our hypothesized sequence. What it does suggest is that the stepwise, sequential model of adoption explains better than the complete package model the pattern of actual farmer adoption of improved wheat technology in Anatolia. If it turns out that supply constraints explain the non-use of some parts of the moisture conservation cluster this model will be still more convincing.

This method of analysis does not mean that the package approach must be dropped in the presentation of the technology to the farmer. It does suggest that if the farmer adopts technology this way, (regardless of advice to the contrary) then we should analyze it this way. With practices ordered and appropriately clustered agronomic experiments of modest scope could help define the expected results of sequential adoption, could give some idea of the progression of yield and income change expected at each level of adoption. These experiments could be extended over different regions and weather years to assess how results and interaction differ by region and by weather.

Breaking packages into a few operationally and agronomically significant clusters, a stepwise analysis would represent a major step toward helping a broad range of farmers. For example, as noted, recent research in Turkey suggests that just getting the small, poor, traditional farmer from step 1 to step 2 can increase his yield by over half. If he can do this several years in a row, he may be able to accumulate enough savings to move up to step 3.

Both this analysis and the interdisciplinary approach embodied in it suggests the need for constant feedback between farmer practices and research experiments. Experimental design should generate data permitting economic analysis of major decisions the farmer faces. We need research not only on where the farmer should be going but research on how he gets there from where he is now. Many farmers have credit and resource contraints (not to mention a healthy skepticism) which prevent them from adopting a new package in a single step. Grouping the elements of the package into clusters offers a manageable yet realistic way to approximate the farmer's decision path without sacrificing benefits of crucial interactions among practices. Being a result of agronomist/economist collaboration this approach should not only meet the concerns of both, but should more closely resemble the farmer's approach to the problem for he is, after all, both agronomist and economist. Moreover, a step-by-step analysis promises the farmer not only a description of his destination but a map on how to get there, complete with calculation of benefits and costs of both waystops and of the full trip.

To suggest providing such information about the ordering and clustering of elements within the package is not to suggest abandoning the package approach in carrying recommendations to the farmer. As noted earlier, this approach has much to commend it. With adoption of the integrated package remaining the goal, a more complete agronomic and economic analysis of how the pieces go together could assist farmers in attaining that goal.

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Acknowledgements

The author thanks Dr. Bill C. Wright for his patient expositions on the agronomy of wheat and Dr. Kutlu Somel, co-designer of the Ankara Wheat Survey. The usual disclaimers apply.

Footnotes

(1) This package is: Earlier and improved tillage of the fallow both to kill weeds and to establish a moisture conserving mulch; phosphorous and nitrogen fertilizers; treated, high yielding varieties sown with drill; herbicide to control weed growth.

(2) In addition to assuring capture of the benefit of all interactions, the package approach holds up for the farmer a clear model to strive for in the long run even if he cannot achieve it in the short run; it simplifies the extension task; it provides dramatic yield increases for full adoptors which can serve to motivate others.