Part II: Diversification and Control of Income Variability

Risk & Diversification in Arizona Crop Farm Planning

*by John Wildermuth, Richard Shane and Russell Gum**

This is the second of a three part series of articles intended to: (1) provide Arizona farmers and agribusinessmen with relatistic estimates of the net income variability associated with selected single crops and crop mixes grown in Arizona, and (2) illustrate the importance of and procedure for allowing for risk and uncertainty in crop farm planning. Part I, (Vol. XXIII, No. 5, September-October, 1971) which served to illustrate, vis-a-vis the "Principle of Increasing Risk" and estimates of the net income variability for 13 single crops grown in Arizona, the importance of and data required for a risk analysis of a given farm planning situation concluded with the following statement:

> "The significance of the variability measures in terms of allowing for risk in farm planning should now be apparent. With the exception of cotton, the crops with a high income potential will lead to large year to year income fluctuations. A farmer must decide whether to produce: (a) high income crops having a correspondingly high risk of losses, (b) lower risk crops having lower average income, or (c) a combination of high and low risk crops. New farmers who have limited capital, or who prefer not to gamble on high risk crops, can choose crop combinations which minimize risk and thus avoid the short-run possibility of bankruptcy. Established farmers, or those who have high risk preference, may wish to concentrate on high risk crops because they believe that high possible incomes may offset greater probabilities of large losses."

Thus, the purpose of this, the second of three articles, is to present estimates of the net income variability of selected rotation schemes. The rotation schemes were selected so as to illustrate the principle effects of diversification and are not intended to be characteristic of actual or recommended cropping systems for any given area of the state.

Table 1: Ranking of Arizona Crops and Crop Combinations by Net income Variability Coefficients[1 2] (All crops are in equal proportion)

Combination Crop	*Average Net Income*	*Variability Coefficient*	*Combination Crop*	*Average Net Income*	*Variability Coefficient*
C-B	($) 109	(%) 16	A-C-B	($) 88	(%) 15
C-A	112	17	C-B-M	85	16
SB-B	56	26	A-C-SB	113	17
SB-M	59	26	A-SB-Wh	48	22
C-CR	348	36	B-M-Sa	22	28
Cr-Sl	484	37	A-B-M	27	29
Cr-Fl	437	37	A-C-Ca	166	39
Cr-O	599	46	A-Ca-Cr	263	39
Fl-O	536	48	C-B-P	129	40
Ca-Sl	359	49	A-Cr-Wh	183	42
Ca-Fl	312	52	Sl-Cr-O	554	43
P-Wa	139	55	Sl-Ca-SB	273	43
Fl-Wa	249	56	C-Sl-M	234	48
Fl-Sl	422	57	A-SB-P	96	49
P-O	426	59	A-SB-Ca	128	51
Ca-O	474	62	Fl-SB-P	210	52
Ca-Wa	186	65	Sl-O-P	439	54
Ca-A	139	69	A-Fl-Sl	293	55
Fl-A	201	70	Sl-M-SB	197	55
Fl-B	197	71	A-Sl-SB	199	56
C-B-M-Wh	68	15	A-C-M-Wh-SB	77	17
A-C-M-Wh	72	16	A-C-M-B-SB	78	17
A-C-B-Sa	71	17	A-M-B-SB-Sa	40	21
A-C-B-SB	91	17	A-C-SB-P-Ca	152	29
C-B-M-Sa	69	17	A-C-SB-P-B	104	31
C-SB-Wh-Sa	85	18	A-M-Cr-Sl-Fl	284	33
SB-B-M-Sa	41	22	C-M-B-SB-Ca	122	33
A-B-M-Wh	25	28	C-B-P-Sl-Ca	224	35
A-C-P-Cr	227	28	A-C-SB-Sl-Ca	214	35
A-C-P-Ca	165	32	C-Sl-Fl-Ca-Wa	290	36
A-SB-Cr-Fl	254	32	A-C-P-O-Cr	322	36
SB-Ca-P-Sl	249	38	B-M-P-SB-Ca	112	37
Sl-Cr-O-Wa	452	40	A-B-Wh-Ca-Cr	167	37
Sl-Fl-Ca-P	318	40	A-SB-P-Wa-Ca	135	37
A-Sa-Ca-P	118	41	P-O-Cr-Wa-Ca	350	38
A-Cr-O-P	350	41	A-SB-O-Cr-P	299	38
C-M-Ca-Wa	156	41	M-SB-P-O-Cr	298	39
M-O-P-Cr	348	41	A-P-Sl-Fl-Ca	261	40
O-Cr-Ca-Wa	398	42	A-M-P-O-Cr	285	40
B-P-Ca-Wa	142	42	B-M-P-Ca-Wa	119	41

[1] *Symbols—Crop A, Alfalfa; B, Barley; C, Cotton; Ca, Cantaloupes; Cr, Carrots; Fl, Fall Lettuce; Sl, Spring Lettuce; Wa, Watermelons; Wh, Wheat; SB, Sugar Beets; O, Onions; P, Potatoes; M, Milo.*

[2] *Net Income as used here refers to the net returns above direct growing and harvesting costs (variable costs) for each crop as estimated from secondary sources. See the footnotes to Part I for full details. Fixed costs such as depreciation, taxes, and interest on the investment have not been subtracted as it is inappropriate to assign them to an individual crop. Fixed costs will be introduced in the whole farm analyses, Part III, in this series of articles.*

Crop Diversification and Income Variability

Diversification can be accomplished in two basic ways: (1) by

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adding resources and (2) by the redistribution of a fixed resource base. In either event, an ideal combination of crops from the standpoint of lessening income variability, is one wherein the low income from one crop is offset by a high income from another crop, and vice-versa. However, as the data pertaining to both of these two types of diversification, Tables 1 and 2, respectively, indicate even if the emphasis is on lessening income variability an "ideal combination" of crops may be difficult to settle upon. First consider diversification type 1, Table 1.

Diversification by Adding Resources

Various crop diversification schemes involving equal proportions of 2, 3, 4, and 5 crops successively are ranked in Table 1 according to their variability coefficient. Recall from "Part I" that the variability coefficient shows in percentage terms the degree of random (unpredictable) variation relative to the estimated average net income; e.g., the year to year variation in net income from a farm involving ½ cotton and ½ barley can be expected to be .16 × the average net income or $17.44/acre.

A careful inspection of the data in Table 1 reveals that as expected diversification by adding resources to include an equal amount of an additional crop into the rotation does generally lead to a reduction in both variability and net income. With only 2 crops the variability coefficient and net income range is, respectively, 16%-71% and $56-$599 whereas with 5 crops the comparable ranges are 17%-46% and $40-$350, respectively.

The data in Table 1 also substantiates, as did the individual crop data presented in Table 1 — Part I, the generally held view that the farmer must make a choice between an unstable income at a high average level and a more stable income at a lower level. The data in Table 2 further supports this contention.

Diversification by Redistribution of Fixed Resources:

The second method of diversification is to redistribute a fixed quantity of resources, capital, land, etc., among additional enterprises. This method of diversification makes the risk impact of alternative crop mixes readily apparent because it involves changing the proportions of the mix and not the crops. Thus, in Table 2 numerous crop mixes are investigated, but in each of the 6 situations analyzed there are only 4 crops involved. Diversification occurs as a result of the reallocation of a fixed acreage, .60 acres, away from cotton and to an alternate crop. The other two crops, barley and alfalfa, are held constant at .20 acres each.

The data arrayed in Table 2 also reveals that, while in general high net income and high variability do tend to go together, there is considerable potential for risk management through selection of diversification schemes. For example, consider the case of

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Table 2: Ranking of various Arizona Crop Diversification Schemes by Net Income Variability Coefficients with .2 acres Barley, .2 acres Alfalfa, and varying proportions of Cotton and the Alternate Crop.

Acres Used For Cotton	Alternate Crop	*Average* Net Income ($)	*Variability* Coefficient (%)	*(% of Time) Net Income Greather Than* 60% ($)	90% ($)
	SUGARBEETS				
.60	0	137	15	132	110
.50	.10	126	16	121	100
.40	.20	114	16	110	90
.30	.30	103	17	99	80
.20	.40	92	19	87	70
.10	.50	80	21	76	59
0	.60	69	25	65	47
	ONIONS				
.60	0	137	15	132	110
.50	.10	186	29	173	118
.40	.20	235	41	211	110
.30	.30	284	50	248	101
.20	.40	333	57	289	93
.10	.50	382	61	324	82
0	.60	431	65	361	73
	CANTALOUPE				
.60	0	137	15	132	110
.50	.10	142	19	135	108
.40	.20	147	28	136	94
.30	.30	151	38	137	77
.20	.40	156	48	137	59
.10	.50	161	58	138	41
0	.60	166	68	138	22

Acres Used For Cotton	Alternate Crop	*Average* Net Income ($)	*Variability* Coefficient (%)	*(% of Time) Net Income Greather Than* 60% ($)	90% ($)
	FALL LETTUCE				
.60	0	137	15	132	110
.50	.10	154	25	144	104
.40	.20	171	37	155	90
.30	.30	188	47	166	74
.20	.40	205	56	176	58
.10	.50	222	64	187	41
0	.60	239	70	197	25
	WATERMELON				
.60	0	137	15	132	110
.50	.10	129	19	123	98
.40	.20	121	25	113	82
.30	.30	112	34	103	64
.20	.40	104	45	93	45
.10	.50	96	58	82	25
0	.60	88	74	72	5
	POTATOES				
.60	0	137	15	132	110
.50	.10	132	19	124	99
.40	.20	127	27	118	83
.30	.30	122	38	110	63
.20	.40	117	49	102	43
.10	.50	112	63	94	22
0	.60	107	77	86	1

Risk & Diversify

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sugar beets and cotton at .30 acres each. Given the corresponding average net income, $103, and variability coefficient, 17%, the expected net income varies by $19 over the 60 to 90% probability range — as explained previously in part 1, a 60 (90)% probability level should be interpreted to mean that at least 6 (9) years out of ten net income can be expected to be as high or higher than the amount shown. In contrast at the same .30 crop mix the net income spread over the 60 to 90% range for cotton and fall lettuce is $92. However, with the more stable sugar beets the $19 range is from $80 to $99 while with fall lettuce the $92 range is from $166 to $74. Thus, based on both net income and risk considerations fall lettuce at .30 appears far superior to sugar beets at .30 for even if the farmer undertaking such a diversification scheme had a very bad year (net income should be as low or lower than the 90% figure only one year out of ten) the lettuce diversion net income can be expected to be nearly as good as the sugarbeet diversion net income, $74 versus $80. Moreover, under a reasonably good year (6 out of 10) the net income from the lettuce diversion is far superior to the corresponding sugar beet diversion net income, $166 versus $99.

A comparison of the results reveals quite a different picture if the diversion of cotton is carried to the extreme where all .60 acres are put in fall lettuce. Under a reasonably good year, the expected net income for the .60 acre lettuce rotation would be a whopping $197/acre or greater. However, the comparable return at the 90% level is only $25. Clearly a farmer who has a fixed debt amounting to $75/acre/year might logically choose not to risk the $50/acre cash loss and potential bankruptcy associated with the $239 average net income from a .60 acre lettuce mix when a .30 acre sugar beet mix results in a reasonable and secure $103 average net income. Appropriately, in Part III, "Allowing for Risk in Arizona Crop Farm Planning," (forthcoming in the January-February issue), we will complete the process of developing the procedure for the practical application of the "Principle of Increasing Risk" by introducing debt retirement and farm fixed cost considerations.

Cutting Alfalfa for Hay Timed to Reduce Buildup of Lygus Bug Populations

*by G. D. Butler, Jr., M. H. Schonhorst and F. Watson**

Populations of lygus bugs, particularly *Lygus hesperus* Knight in Arizona, build up in alfalfa fields in the summer months and migrate to cotton and other nearby crops when the alfalfa is cut for hay. Results of recent studies of the growth of alfalfa and analyses of biological data of lygus bugs indicated that the number of lygus bugs migrating from alfalfa fields may be greatly reduced by shortening the interval between cuttings of alfalfa in the early summer months when lygus bugs are important pests of cotton.

Populations of lygus bug adults in alfalfa may increase 3.6-fold every 10 days in May and June, as indicated in Table 1. This rapid increase, if permitted to develop by delays in the cutting of the alfalfa for hay or by the withholding of irrigation because of greater need of water for cotton or other crops, can result in development of high populations of lygus bugs in alfalfa. The study field in Table 1 and several other alfalfa fields were adjacent to cotton fields. An insecticide was applied to the alfalfa just

Table 1. Populations of lygus bug adults in alfalfa in May-June 1969. Eloy, Arizona.

No. days after alfalfa cut for hay	*No. adult lygus bugs per 100 net sweeps*
20	58
25	110
30	209
35	396
40	752
45	1426

before it was cut to prevent mass migration of lygus bugs from the alfalfa fields to the cotton. In addition to the expense of the insecticide and its application, beneficial insects, parasites and predators, were killed. Many lygus bug adults moved into the cotton before the alfalfa was treated necessitating insecticidal application which reduced predator and parasite popu-

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