6. Planning expedient water expenses in specific conditions for actual yield and level of agricultural production

6.1. Expedient water expenses for actual crop yield

One of the main theses of agricultural economy in Soviet period was thesis about maximum agricultural production per unit of irrigated area. Extensive way of irrigated agriculture development was caused by slogan "plan by any price". Often "planned" indicators were achieved at expense of unaccounted lands but not due to advanced agrotechnique. Losses from agricultural production were covered by state.

Under market economy all responsibility for losses bears farmer. His objective is to receive maximum profit. Thus, he should determine production expedient maximum under current market situation. Scheme of external and internal factors influence on net profit is shown on Fig.8.

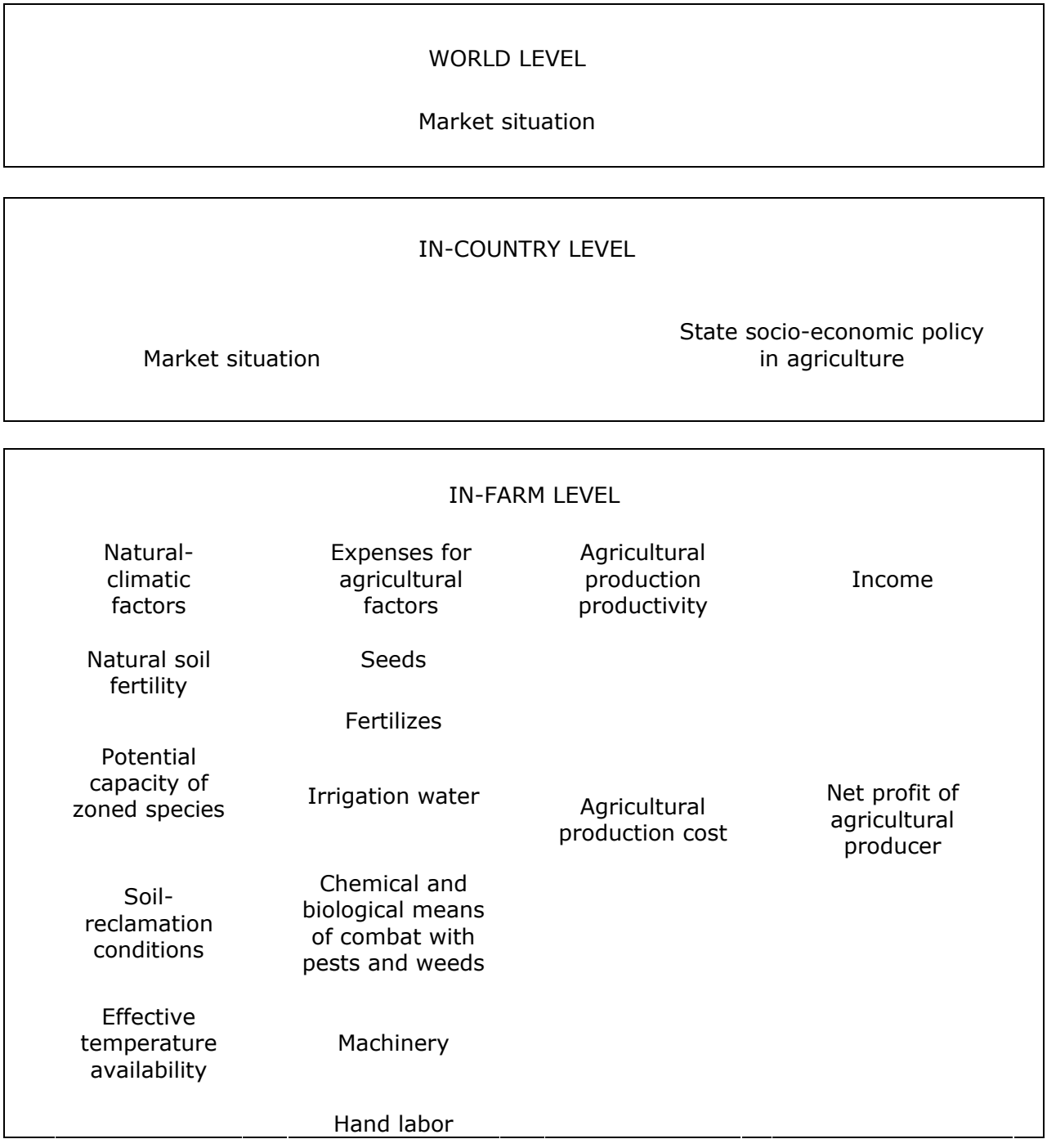

Fig. 8 | Impact of various levels of production on producer's profit

Agricultural production is based on certain natural-climatic factors: natural soil fertility, potential capacity of zoned crops, soil-reclamation conditions, thermal resources availability.

These factors are beyond producer's influence. Receiving good yield requires expenses for: seeds, fertilizers, irrigation water (under paid water use), machinery and hand labor.

Result of this activity is agricultural production cost and received profit.

Size of profit depends on farmer activity but also on external factors: state socio-economic policy in agriculture, price in internal and external market.

We propose approach to evaluation of expedient productivity level and irrigation water expenses. Suggested version of this task solution scenario foresees three levels:

- At first level – crop capacity corresponding maximum income of agricultural production for specific conditions is defined.
- At second level – irrigation water use productivity corresponding to maximum income is defined.
- At third level – expedient expenses of irrigation water are defined.

As basic data we use results of measurements carried out in 1998 within WUFMAS project for fine-fiber cotton in farms No. 17-18 (Turkmenistan) (Table 5).

Table 5 | Major indicators of raw cotton production according to WUFMAS-98 (Turkmenistan, Mary oblast, Bairamali rayon, farms No. 17, 18)

Field code	Yield	Water expenses	Cost of inputs	Cost of sold cotton	Farm's net profit
	t/ha	th.m³/ha	$/ha	$/ha	$/ha
17-4	2.63	7.50	136.5	544.7	408.2
17-5	3.49	6.33	143.8	722.3	578.4
17-6	3.74	6.68	182.1	773.3	591.2
17-8	2.67	5.58	118.0	552.7	434.7
18-4	1.83	6.67	227.3	378.9	151.6
18-5	1.60	4.82	146.0	330.7	184.7
18-8	1.66	6.16	167.9	343.2	175.3
18-9	1.80	5.73	186.3	373.5	187.2
18-10	2.48	4.57	202.8	514.4	311.5

6.2. Expedient cotton yield corresponding to maximum income of 1998

Relation of received profit (production cost minus expenses) to operation cost is taken as a main indicator of assessment. This indicator dependence of cotton yield is approximated by polynom of second degree (Fig.9).

$$P/S = a*Y^2 + b*Y - 1 \quad (5)$$

where

P - profit from agricultural production, $/ha

S - operation costs, $/ha

Y - raw cotton yield, t/ha

a, b - coefficients of polynom of second degree

Cotton potential capacity of 5t/ha for zoned in the region medium-fiber cotton species is taken as boundary condition for maximum capacity.

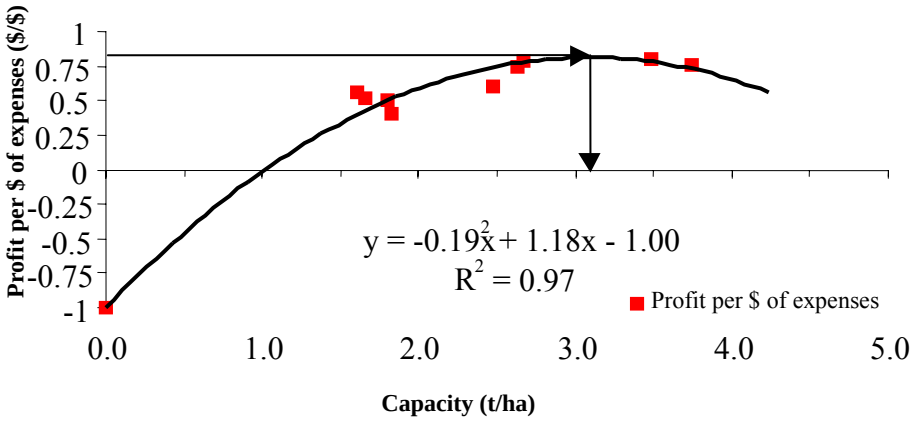

Fig. 9 | Relation between profit per $ of expenses and medium-fiber cotton yield (Turkmenistan, Farms No. 17-18, WUFMAS-98)

Maximum relative profit – 0.81$ per 1$ corresponds to expedient one for farms No. 17 and 18 in Turkmenistan under existing prices for cotton and inputs and yield 3.1 t/ha.

6.3. Irrigation water use productivity corresponding to maximum profit

At the second stage irrigation water use productivity is defined (relation between production cost minus operation costs and actual irrigation norm "gross-field") corresponding to maximum relative profit.

Relation between irrigation water use productivity and cotton yield is approximated with satisfactory reliability by polynom of second degree (Fig.10).

$$P/M_{бр} = c*Y^2 + d*Y - k \quad (6)$$

where

P - profit from agricultural production, $/ha

$M_{бр}$ - operation costs, $/ha

Y - raw cotton yield, t/ha

c, d, k - coefficients of second degree polynom

This relation is true within diapason of yield not exceeding potential one. It is necessary to paid attention to some contradiction of objectives "maximum profit from agricultural production" and "maximum irrigation water use productivity".

Data obtained from farms No. 17-18 are presented by diagram on Fig. 10.

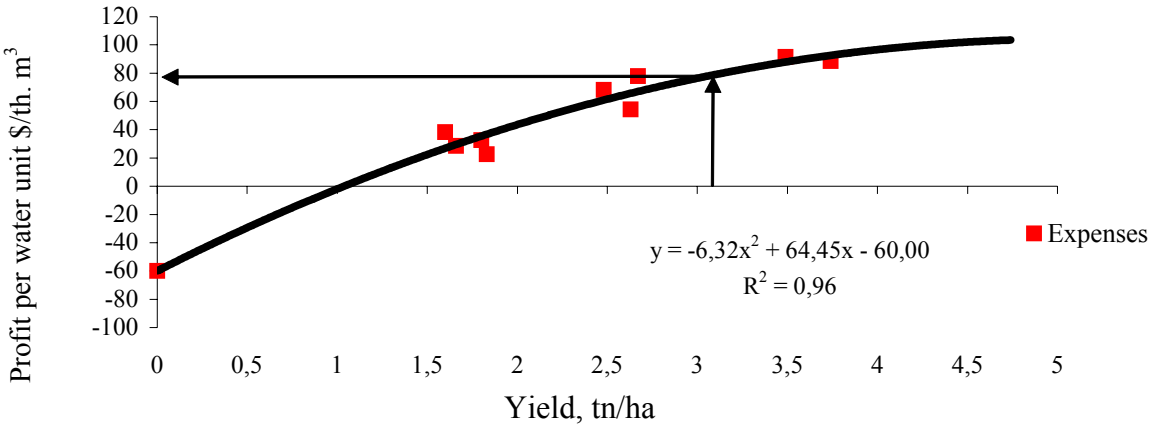

Fig. 10 | Irrigation water use productivity dependence of raw cotton yield (Turkmenistan, farms #17-18, WUFMAS-98)

Irrigation water use productivity under potential cotton capacity 5t/ha is 100 $/th.m^3. But increased expenses for inputs for potential level providing under existing prices would be less compensated by profit.

Thus, irrigation water use productivity 79.1 $/m^3 corresponds to expedient one for farms under prices of 1998 and cotton yield 3.1 t/ha.

6.4. Irrigation water expenses «gross-field» corresponding to maximum profit from agricultural production

At the third stage is defined water expenses corresponding to maximum profit from actual irrigation norm "gross-field" per unit (ton) agricultural production.

Relation is approximated with satisfactory reliability by polynom of second degree (Fig.11).

$$SW/Y = -e*(P/SW)^2 + d*(P/SW) + g \quad (7)$$

where

SW - actual irrigation norm – «gross-field», th.m^3/ha

Y - raw cotton yield, t/ha

P - profit from agricultural production, $/ha

e, d, g - coefficients of second degree polynom

This relation is correct within irrigation water productivity unit not exceeding maximum "theoretical" productivity determined at preceding level. In our example – 100 $/th.m^3 (Fig. 10).

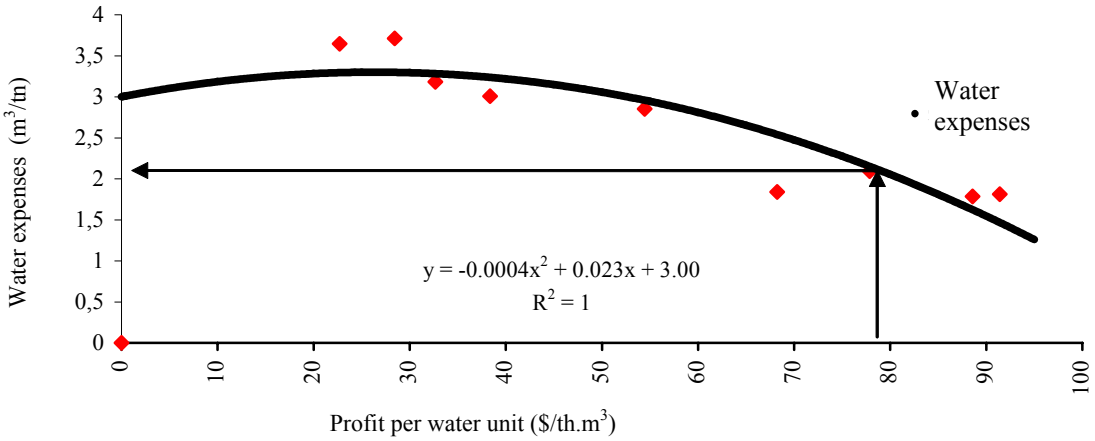

Fig. 11 | Example of relation between irrigation water expenses and established level of its use productivity

Thus, expedient irrigation water expenses 6.4 th.m³/ha correspond to expedient raw cotton yield – 3.1 t/ha providing maximum profit.

This example illustrates the fact that irrigation water expenses planning in conditions of its scarcity is necessary to carry out for economically expedient (under existing prices) maximum yield.