SUMMARY

The sub-mountainous zone of the Punjab State is situated below the Himalayan range of Shivalik hills. The soils are hard clays, sand and conglomerates and shaped through erosion of the upper regions. During monsoon season, the seasonal hilly torrents bring large amount of sand gravel in flashy floods down the hilly streams, locally knows as “Choies”. The inhabitants possess small land and other resource endowments thus could obtain low incomes and thus maintained a poor living.

The State Government realized the need for the development of this area and in the year 1979-80 launched an ambitious development project called the ‘Kandi Watershed and Area Development Project’ with funds from the World Bank. The emphasis of the project was on sustainable development of the zone and replicability of the treatment practices. Another project, ‘Integrated Watershed Development Project (IWDP-Hills)’ was made operational in the year 1990-91. The most important aspect of the project evaluation was the levels of resource use, use-efficiency and the associated productivity and the income levels.

The production resources are scarce and call for a judicious use. There are instances showing that the farmers often use their resources sub-optimally. Some farmers may attain maximum physical productivity per unit of land at a high cost, some others achieve maximum profit per unit of inputs used. In the light of this, the scientific investigations on the use of production resources in farm business are very vital for bringing out their use efficiency. Thus, the present study is an attempt to fill up this gap with the following specific objectives:

1. To analyze the existing pattern of farm resource use and the associated income levels, and
2. To identify the economic gaps in the existing resource-use and the prescription for their optimal use and estimation of the income levels associated with that level of use.

The following hypotheses were constructed for this investigation:

1. The farm resource endowments were small but improved under the development project activities.
2. The existing use of farm resources was sub-optimal. Although, it improved under the project activities but was still away from the optimal level of use.
3. The farm incomes rose under the development project activities. But these levels could improve further through the optimization of resource use.

MATERIAL AND METHODS

The sample for this study was drawn using the three stages stratified random sampling technique. The block was the first stage, village the second stage and operational farm the third and ultimate unit of sampling. There are eighteen sub-mountainous blocks, seven blocks are those where development activities were carried out under the Watershed and Area Development Projects. The remaining eleven blocks did not receive such public developmental intervention. So the first category of seven blocks was termed as the Project Blocks and the second category of eleven blocks were designated as Non-project Blocks. Two blocks from each above group were randomly selected for this investigation.

Ten per cent of the sub-mountainous villages were randomly selected for this study. It provided a sample of six villages in Project Blocks and thirteen villages in Non-project Blocks. The operational holdings were categorized into marginal (< 1 ha), small (1-2 ha), medium (2-4 ha) and large (> 4 ha). A sample of ten per cent farms was randomly drawn without replacement from each size-group of farms in each selected village. This provided a study sample of 100 farmers from each group of study blocks.

The primary and secondary data were collected. Regression Analysis, Linear Programming and Timmer’s Coefficient of TE were used for the analysis

RESULTS AND DISCUSSION

Resource Pattern And Use Profile

The average size of the holdings was 0.78, 1.69, 3.11 and 7.02 ha; 0.71, 1.58, 3.12 and 6.74 hectares for marginal small, medium and large farms respectively in Project and Non-projects Blocks.

The total human labor available on farms was 3.40, 3.26, 3.19 and 4.05 and 3.70, 3.17, 2.78 and 3.95 man units on marginal, small, medium and large farms respectively in Project and Non-project Blocks.

The irrigation water was available for 127, 152, 191 and 217 hours on marginal, small, medium and large farms respectively in project area only. But in Non-project area there was no man made irrigation source and farming was mostly rainfed.
Tractor draft power available was for 318, 784, 911 and 1152 hours and 167, 269, 396 and 506 on marginal small, medium and large farms respectively in Project and Non-project area. Thus the mechanization level was higher on Project area farms. The bullock labour was available for 21, 58, 69 and 31 pair hours and 79, 163, 247 and 401 pair hours in Project and Non-project area on marginal, small, medium and large farms respectively.

The average number of milch animals was higher in Non-project area due to the presence of goats but the proportion of cross breed cows in Project area.

In Project area, Maize and fodder in kharif and wheat and fodder in rabi were the major crops. The cropping intensity was 183.33, 185.80, 174.28 and 175.36 per cent on respective farm sizes. In Non-project area, maize was the major kharif crop on marginal, small and medium farms and paddy on large farms. Wheat was the major rabi crop.

Total RFFRs from crops were Rs. 33164, 32357, 32996 and 30148 per hectare on marginal, small, medium and large farms respectively in Project area, while it was Rs. 32713 on marginal, Rs. 30112 on small, Rs. 32518 on medium and Rs. 31519 on large farms in Non-project area.

In Project area, the lowest variable cost per hectare was on sesamum followed by pulses in kharif season. In the rabi season variable cost was the lowest on rapeseed and mustard. Among milch animals, the highest variable cost came to be on buffaloes. The variable cost on per hectare of total crops was positively correlated to the farm size. Similar was the pattern in case of variable cost per milch animal. An identical pattern of variable costs was observed in case of Non-project area farms.

The share of crops in the total returns to the fixed farm resources was 38.42, 51.76, 61.44 and 61.99 per cent and 44.61, 56.68, 62.91 and 74.50 per cent on marginal, small, medium and large farms respectively in Project and Non-project areas.

In Project area, the proportion of human labor use in crop activity was 23.90, 36.78, 43.59 and 46.08 per cent and 14.02, 23.53, 28.37 and 42.47 per cent on marginal, small, medium and large farms respectively in Project and Non-project area. The share of livestock in the human labor use on the farm decreased with the increase in farm size, whereas the reverse in case of crops.
REGRESSION ANALYSIS

Project Area

Maize Crop:

In Project area, the crop area, use of FYM and human labour positively affected the gross value product (GVP) of maize, while the use of bullock labour was excessive, on small farms, increase in GVP was possible with an increase in crop area, improved varieties of seed and human labour use. There was an over use of bullock labour on these farms.

On medium farms, the coefficients crop area, FYM and human labour use were positive and significant, while the excessive use of bullock labour was also observed on medium farms. On large farms, the coefficient of crop area, value of seed and tractor use came to be positive and significant while that of irrigation came to be negative and significant.

On the whole, crop area, seed quality human labour and tractor use emerged as the significant contributors to GVP of maize crop in Project area.

Kharif Fodder

On marginal farms, the coefficients of crop area, value of seed, use of FYM and bullock labour use was found to be positive and significant. It indicated than an increase in crop area, value of seed, FYM and bullock labour use an increase would increase the GVP of kharif fodder on small farms in Project area. On medium farms, the positive and significant coefficient of crop area, use of FYM, human labour use and bullock use indicated an increase in GVP of kharif fodder with the increase in the use of these inputs. On large farms, the crop areas, use of FYM and human labour use contributed positively towards GVP of kharif fodder.

Wheat Crop

On marginal farms, the positive and significant coefficients of crop area, value of seed, irrigation and cost on plant protection measures indicated that there would be an increase in GVP of wheat with an increase in these inputs. On small farms in project area, the crop area, value of seed, human labour use and tractor use contributed significantly towards GVP of wheat. On medium farms, the increased use of fertilizers, number of hoeings affected the
GVP of wheat positively. Significantly excessive use of plant protection measures, human labour and tractor was observed on the production of wheat on medium farms. The judicious use of these inputs would raise the returns. On large farms, the positive and significant coefficients of crop area, value of seed and irrigation indicated their positive contribution towards GVP of wheat. While plant protection measures and tractor use were excessive on production of wheat crop on large farms in Project area.

**Rabi Fodder**

On marginal farms, the coefficients of crop area, use of N and human labour were positive and significant. However, irrigation and bullock labour were in excessive use on these farms. On small farms, the positive and significant coefficients of FYM use, irrigation and human labour indicated that the increase in these inputs would raise in GVP of rabi fodder. On medium farms, the coefficient of crop area and human labour use were positive and significant, while N use was excessive. The regression coefficient of FYM and human labour came to be positive and significant, while the use of N and tractor was found to be excessive on the large farms.

**Total crops**

On marginal farms, the significant coefficients of cropped area, use of FYM and human labour use indicated that an increase in these inputs would increase the GVP of crops. The coefficient of N use showed that use of N needed redressal. On small farms, the regression coefficients of cropped area, irrigation, human labour and P use were found significant. On medium farms, the contribution of cropped area, FYM and irrigation use positively affected GVP from crops. While the excessive use of irrigation adversely affected the GVP of crops. On large farms, the positive and significant coefficient of cropped area, FYM and human labour use indicated that there would be a further increase the GVP from crops with the increased use of these inputs. The negative and significant coefficients of plant protection and tractor use revealed that large farmers were using these two resources injudiciously.

**Non-project Area**

**Maize**
On marginal farms, the coefficients of value of seed, FYM, human labour and bullock labour use were positive and significant. This showed that an increase in the application of these inputs would further improve the GVP of maize on marginal farms. On small farms in Non-project area, the regression coefficients of crop area, use of FYM and human labour were positive and significant, while the application of N was excessive. On medium farms, the positive and significant coefficients of crop area, use of FYM, bullock labour and application of N indicated that an increase in these inputs would increase in the GVP of maize. On large farms, the coefficients of crop area, use of FYM and tractor were positive and significant.

**Paddy:**

On marginal farms, the positive and significant coefficients of crop area, use of FYM, application of N and human labour use indicated the positive role of these inputs towards GVP of paddy. On small farms, the coefficient of crop area, application of N and human labour use were significant. On medium farms, the positive and significant coefficient of crop area, human labour and tractor use showed an increase through in GVP increased use of above-mentioned inputs. On large farms, the contribution of crop area, application of N and tractor use was positive and significant.

**Wheat**

On marginal farms in Non-project, the contribution of crop area, value of seed, application of N and human labour was found to be positive and significant towards GVP of wheat. On small farms, the positive and significant coefficients of area under wheat, application of N, human labour and bullock labour use indicated that increased use of these inputs could increase the GVP of wheat. On medium farms, the contribution of crop area, application of N and tractor use was positive and significant. On large farms, the positive and significant coefficients of crop area, application of N and tractor use showed that the increased use of above inputs could increase the GVP of wheat.

**Total crops**

On marginal farms, the positive and significant coefficients of cropped area, use of FYM and human labour indicated that there could be a further increase in farm gross returns with an increased use of these inputs. The excessive use of bullock labour on crops adversely affected the gross value. On small farms, the positive and significant coefficients of cropped
area, value of seed, application of N and P and human labour indicated that increased use of these inputs could increase the GVP from crops on small farms. On medium farms, the contribution of cropped area, value of seed, FYM, and tractor use could positively impact gross returns from crops. The expenditure on fertilizers was excessive and needed to be rationalized. On large farms, the coefficients of cropped area, human labour, tractor use and application of N and P were significant. This showed that these inputs contributed positively.

Livestock Activities

Project Area

On marginal farms, the positive and significant coefficients of number of milch animals, green fodder, concentrates and veterinary services indicated their potential to increase the gross returns from livestock. On small farms, the regression coefficients of number of milch animals, concentrates and veterinary services were significant. On medium farms, the contribution of number of milch animals, concentrates and human labour use was found to be positive and significant towards gross returns from livestock. In case of large farms, the positive and significant coefficients of number of milch animals, dry fodder and human labour showed an increase in gross returns from livestock through increased use of above inputs on large farms.

Non-project Area

On marginal farms, the role of number of milch animals, green fodder, concentrates and veterinary services was found to be positive to gross returns from livestock. Human labour was found to be used excessively on dairy farms. On small farms, the positive and significant coefficients of number of milch animals, green fodder, concentrates and veterinary services indicated that an increase in these inputs could increase gross returns from livestock. On medium farms, the contribution of number of milch animals, concentrates and veterinary services was positive on gross returns from livestock. On large farms, the coefficients of number of milch animals, green fodder, concentrates and veterinary services were positive and significant. This showed that an increase in these inputs could increase the gross returns from livestock on large farms.

TECHNICAL EFFICIENCY IN CROP PRODUCTION

Maize

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**Project Area**

The marginal farmers of project area attained the technical efficiency (TE) of 54.35 per cent. This showed that there was still a scope of attaining 45.65 per cent higher efficiency in the production of maize. The small farmers attained the TE of 61.03 per cent. This showed that there was still a scope of attaining 38.97 per cent higher efficiency in the production of maize on small farms. The medium farmers attained the TE of 70.67 per cent and it could be raised by 29.37 per cent. The large farmers attained the TE of 76.00 per cent with a scope to raise it by 24.00 per cent.

**Non-project Area**

The marginal farmers had a TE of 47.82 per cent. The small farmers possessed a TE of 55.20 per cent. Whereas the medium farmers attained the TE 62.00 per cent and the large farmers attained the TE of 71.00 per cent.

**Kharif Fodder**

**Project Area**

The overall level of TE in production of kharif fodder came to be 57.39, 61.38, 70.67 and 73.00 per cent on marginal, small, medium and large farms respectively.

**Non-project Area**

The overall level of TE in the production of kharif fodder was 51.82, 54.40, 61.00 and 67.00 per cent on marginal, small, medium and large farms respectively.

**Wheat**

**Project Area**

The marginal farmers attained the TE of 57.83 per cent, small farmers 64.48 per cent, medium farmers 74.00 per cent and the large farmers 78.00 per cent in wheat production.

**Non-project Area**

The TE in wheat production in Non-project area stood at 55.45, 59.60, 67.00 and 73.00 per cent on marginal, small, medium and large farms respectively.

**Rabi Fodder**

**Project Area**

The level of TE in the production of rabi fodders was 55.87, 57.24, 69.33 and 72.00 on marginal, small, medium and large farms respectively.

**Non-project Area**

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The level of TE in production of rabi fodders was 49.09, 51.60, 64.00 and 69.00 on marginal, small, medium and large farms respectively.

**Total Crops**

**Project Area**

The level of TE in the production of total crops was 50.87, 55.52, 63.33 and 72.00 on marginal, small, medium and large farms respectively.

**Non-project Area**

There was a TE of 48.73, 52.40, 60.00 and 69.00 on marginal, small, medium and large farms respectively in Non-project area.

It could be brought that the level of technical efficiency in the production of individual major and overall crops had a positive correlation with the size of the farm in both the study areas.

**OPTIMAL FARM PLANNING**

**Project Area**

**Marginal Farms**

In optimal plan-I, there was a major shift of area under maize (desi), sesameum and pulses to groundnut and vegetables due to the higher RFFRs from the latter crops. The cropping intensity increased from 183.33 per cent to 200.00 per cent. Goats disappeared from the scene. The number of remaining milch animals increased from 1.67 in the existing plan to 1.74 in optimal plan-I on marginal farms in project area. Therefore, in optimal plan-I, the RFFRs worked at Rs. 64389 per farm in place of Rs. 59812 in the existing plan. This registered an increase of 7.65 per cent over the existing plan.

In optimal plan-II, the area under maize desi declined and shifted towards maize (HYV), paddy, groundnut and vegetables. During rabi season, wheat fetched more area after a shift from pulses and vegetables. The RFFRs increased further to Rs. 69728 in optimal plan-II. This registered an increase of 16.58 per cent over the existing production plan and 8.29 per cent over optimal plan-I.

**Small Farms**

In kharif season, in optimal plan-I, area shifted from maize desi, pulses and sesameum to paddy, groundnut, vegetables and fodder. In rabi season, the area from rapeseed and mustard and pulses shifted to wheat, vegetables and fodder. Total cropped area increased from
3.14 hectares in the existing plan to 3.34 hectares in optimal plan-I. Total number of milch animals increased from 2.21 in the existing plan to 2.26 in optimal plan-I. Thus, in optimal plan-I, the RFFRs worked at Rs. 100846 per farm in place of Rs. 95761 in the existing plan. This registered an increase of 5.31 per cent in RFFRs over the existing plan.

In optimal plan-II, during kharif season the increase in almost all the kharif crops materialized by shifting the area from maize (desi). During rabi season, the area under wheat witnessed an increase, while area under rapeseed and mustard vanished. The number of milch animals increased from 2.26 to 2.43 in optimal plan-II. The RFFRs increased further to Rs.106631 in optimal plan-II. This registered an increase of 11.35 per cent over the existing production plan and 5.74 per cent over optimal plan-I.

Medium Farms

In kharif season, in optimal plan-I, there was a major shift of area under maize (desi), sesamum and pulses to maize (HYV), paddy, vegetables and fodder. In rabi season, the increase in area under wheat, vegetables and fodder could be materialized reducing the area from rapeseed and mustard and pulses. Total number of milch animals increased from 2.40 in the existing plan to 2.50 in optimal plan-I. In optimal plan-I, the RFFRs worked at Rs. 146602 per farm in place of Rs. 140644 in the existing plan, registering an increase of 11.57 per cent in RFFRs over the existing plan.

In optimal plan-II, during kharif season the area under maize (desi) and pulses declined while that under maize (HYV), paddy, vegetables and fodder increased. During rabi season, wheat, vegetables and fodder area witnessed an increase while the area under pulses declined. The number of milch animals increased from 2.50 to 2.70 in optimal plan-II. The RFFRs increased further to Rs.156922 in optimal plan-II. This registered an increase of 11.57 per cent over the existing production plan and 7.04 per cent over optimal plan-I.

Large Farms

In kharif season, in optimal plan-I, There was a major shift of area under maize (desi), sesamum and pulses to maize (HYV), paddy, groundnut, vegetables and fodder. In rabi season, there was an increase in area under wheat, vegetables and fodder. Total cropped area increased from 12.30 hectares in the existing plan to 12.56 hectares in optimal plan-I. Total number of milch animals increased from 5.10 in the existing plan to 5.22 in optimal plan-I on. In optimal plan-I, the RFFRs were Rs. 319775 per farm in place of Rs. 305233 in the existing plan. This registered an increase of 4.76 per cent in RFFRs over the existing plan.
In optimal plan-II, during kharif season the area under maize (HYV), paddy, groundnut and vegetables increased. During rabi season, wheat, vegetables and fodder witnessed an increase while the area under rapeseed and mustard registered a decline. The number of milch animals increased from 5.22 to 5.55 in optimal plan-II. The RFFRs increased further to Rs.343749 in optimal plan-II. This registered an increase of 12.62 per cent over the existing production plan and 7.50 per cent over optimal plan-I.

Non-project Area

Marginal Farms

In kharif season, in optimal plan-I, there was a shift of area under maize (desi), sesamum and pulses to maize (HYV), paddy, vegetables and fodder. In rabi season, there was an increase in area under wheat, vegetables and fodder. The number of milch animals expect goats increased from 1.42 in the existing plan to 1.46 in optimal plan-I. The RFFRs worked at Rs. 48134 per farm in place of Rs. 43542 in the existing plan. This registered an increase of 10.55 per cent in RFFRs over the existing plan.

In optimal plan-II, during kharif season the area under maize (desi) declined while that under paddy and vegetables increased. During rabi season, the area under wheat increased while that of vegetables declined. The number of milch animals increased from 1.46 to 1.49 in optimal plan-II. The RFFRs increased further to Rs. 51414 in optimal plan-II. This registered an increase of 18.08 per cent over the existing production plan and 6.81 per cent over optimal plan-I.

Small Farms

In kharif season, in optimal plan-I, a shift of area under maize (desi), sesamum and pulses to maize (HYV), vegetables and fodder was observed. The increase in area under wheat and vegetables could be done mainly by shifting the area under barley and rapeseed and mustard. Goats were not entered in optimal plans. The number of other milch animals expect goats increased from 1.80 in the existing plan to 1.99 in optimal plan-I. The RFFRs were Rs. 79453 per farm in place of Rs. 73583 in the existing plan. This registered an increase of 7.98 per cent in RFFRs over the existing plan.

In optimal plan-II, during kharif season the area under maize (desi) declined while that under maize (HYV), paddy, vegetables and fodder increased. During rabi season, the area
under wheat and fodder witnessed an increase. The number of milch animals increased from 1.99 to 2.02 in optimal plan-II. The RFFRs increased further to Rs.83549 in optimal plan-II. This registered an increase of 13.54 per cent over the existing production plan and 5.16 per cent over optimal plan-I.

**Medium Farms**

In kharif season, in optimal plan-I, a shift from area under maize (desi), sesamum and pulses to maize (HYV), paddy, vegetables and fodder was seen. In rabi season, there was an increase in area under wheat, vegetables and fodder, which could be done by shifting the area from barley and rapeseed and mustard thus enhancing the cropping intensity. In optimal plans, goats could not mark their entry. The number of other milch animals increased from 2.00 in the existing plan to 2.43 in optimal plan-I. In this way, in optimal plan-I, the RFFRs worked at Rs. 117805 per farm in place of Rs. 107083 in the existing plan. This registered an increase of 10.01 per cent in RFFRs over the existing plan.

In optimal plan-II, during kharif season the area under maize (desi) and sesamum declined while that under maize (HYV), paddy, vegetables and fodder increased. During rabi season, wheat, pulses, vegetables and fodder witnessed an increase in area. The number of milch animals decreased from 2.43 to 2.50 in optimal plan-II. The RFFRs increased further to Rs.127300 in optimal plan-II, indicating an increase of 18.88 per cent over the existing production plan and 8.06 per cent over optimal plan-I.

**Large Farms**

A major shift of area under maize (desi), sesamum and pulses to maize (HYV), paddy, vegetables and fodder was recommended in optimal plan-I. Vegetables registered their entry.

In rabi season, the area under wheat, pulses, vegetables and fodder increased while there was a decline in the area under barley and rapeseed and mustard. Total cropped area increased from 10.18 hectares in the existing plan to 10.59 hectares in optimal plan-I. In place of goat, higher number of buffaloes and cross bredcows was witnessed. The RFFRs worked at Rs. 198656 per farm in place of Rs. 177509 in the existing plan. This registered an increase of 11.91 per cent.

In optimal plan-II, during kharif season the area under maize (desi) and sesamum declined while that under maize (HYV), paddy, vegetables and fodder increased. During rabi season, the area under wheat, pulses, vegetables and fodder witnessed an increase, while the area under barley and rapeseed and mustard declined. The number of milch animals increased
from 3.48 to 3.54 with higher number of cross bred cows, in optimal plan-II. The RFFRs increased further to Rs.210426 in optimal plan-II. This registered an increase of 18.54 per cent over the existing production plan and 5.92 per cent over optimal plan-I.

The findings of this investigation showed that the farm resource endowments on sample farms in Project and Non-project area showed narrow differences. Similarly, crop mixes under both the study locations did not differ widely except a small proportion of area under rainfed paddy and barley present in Non-project area farms. The variable input use brought out that mechanization level was higher and human labour use intensity lower on Project area farms which were also found relatively more capital intensive. This could be possible due to the availability of irrigation water inducing higher use of associated inputs.

The regression analysis pointed to the need for reducing excessive use of human labour, draft power, nitrogenous fertilizer in some cases and increasing the use of better seed, irrigation, manures, fertilizers in other situations. Also there was a focus on increased use of green fodders concentrates and veterinary care in case of livestock activities.

Optimal planning exercises showed area shift in favour of high value crops and high yielding milch animals in place of local cow breed and goats.

The first hypothesis that the farm resource endowments were small but improved under the development project activities could be partially accepted.

The second hypothesis that the existing use of farm resources was sub-optimal, although, it improved under the project activities but was still away from the optimal level of use came to be true.

The third hypothesis was that the farm incomes rose under the development project activities, but these levels could improve further through the optimization of the resource use. This hypothesis also proved to be true through the findings of the study.