Fuzzy Logic Based Simulation for Modeling of Sustainable Marketing Policy for Modern Rice Mills in Odisha

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Abstract – Rice is consumed by 50 per-cent of the world population. It has a strong market demand as the starch and fibers of rice has been reported to be superior to that of wheat. Orissa produces small, medium and long grain rice traditionally which has commercial importance. The strategy for modernization of the traditional technology based rice mills has to be planned. Up-gradation of rice mills must be done by high tech modern technology so that the rice thus produced can be marketed globally at a premium price. Artificial intelligence based fuzzy logic has been used in this model to determine the numbers of rice mill required to be programmed under proposed symbiotic development program over time. The parameters like rice production, variation in production, paddy grain type, production technology and capacity of the rice mill and geographic boundary have been considered to simulate this strategy. Implementation of this strategy can bring a sea change in the economic status of farmers' of Odisha, India engaged in production of paddy which has international acceptance. The suitable climatic factor can be used for growing different paddy varieties and commercially manage it for more profit through value addition and positioning the product in global market.

Keywords - Rice mill, Fuzzy logic, optimal paddy production, Scented rice, Long grain rice, Directorate of Industries, Department of Civil Supplies, Government of Odisha

1. Introduction

Government of Odisha is planning for 3rd green revolution to meet the ever increasing food stress. The reduction in terms of yield or loss of whole rice caused due to improper machinery selection and use during rice milling has been a great concern for all the rice millers, planners and managers in the field. Authors have expressed their concern about optimization of the production through use of Fuzzy Logic (FL) under Multi-criteria decision making condition ([1], [31]). Similar reorientation has been proposed for development of rice mills in sustainable way in Odisha considering multiple variables and FL technique using MATLAB R2011b ([7],[8]). Smaller capacity modern rice mills can be programmed to be set up by private parties with central processing facility by government to produce high value rice for global market at a competitive price. This will create scope for value addition of the rice by-products to make it more profitable. The contour map of number of rice mills has been plotted in Figure. 1 which shows the density of rice mills located in Odisha in

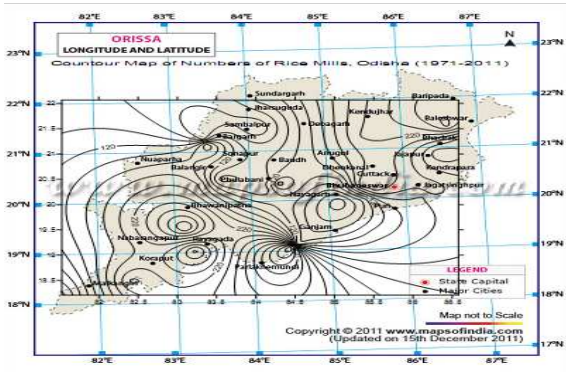

Figure. 1 Contour map of rice mill of Odisha

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a contour form. There are about eight high concentrated clusters of rice mills in Odisha (220 mills in a compact area). It can be used as the hub for rice milling and interim container deport for rice export. Presently the rice hullers yield 10-30% whole raw rice against 80-90% whole rice by modern rice mills (BÜHLER make). This type of modern rice mills will enhance the profit of the millers / farmers. The farmers will come forward to cultivate more area under paddy and supply it globally ([9], [11][11]). The food grain demand has been estimated to be 450 MT by 2050 AD. This target can be achieved through minimization of waste at the processing level as well as bringing more area under food grain (Paddy) by making the production more remunerative. There is a need to determine the rice milling growth rate under mostly uncertain condition. This research addresses this problem of Odisha, India.

Besides production loss the losses during processing must be prevented. The up gradation of technology of rice milling with modern technology will reduce the milling loss and make more food available for human consumption. The marketing of new rice mills as well as up-gradation of the technology is essential in the present context. No attempt has been made so far ([2], [5], [6]) to determine the rice production, change in rice production, types of paddy grown, area and its potential for processing paddy, technology of the rice mill, availability of the rice milling machinery and use it for a matching policy and logistics. Following two objectives are framed for total rice milling industrial development of Odisha.

1. Number of rice mills to be promoted for sustainable development of quality of rice in Odisha.
2. Verify the result with conventional prediction methods.

2. Review on Marketing and Logistics, Strategy of Installation of Rice Mills in Odisha, India

The agricultural development planning are not standardized ones. Further the agricultural planning follows zero budgeting The studies are centered on parameter optimization in single dimension or in multiple combinations ([17], [29], [30], [32]) The production, funds spent on the production of paddy alone, and its processing needs have never been studied. Policy for development of rice mills in a strategic manner using management tools are not practiced in government planning level. Although incentives in form of financial grant, aid, subsidy are provided by state as well as central government these are not properly framed for better efficiency and effectiveness ([12], [21]).

Prediction in form of projected facts based on real time data has been the playground of the researchers. The outcomes from analysis of the real time data for formulation of plan required for rice mill development are expected to be very good. The FL is mostly suitable for highly uncertain, unstable

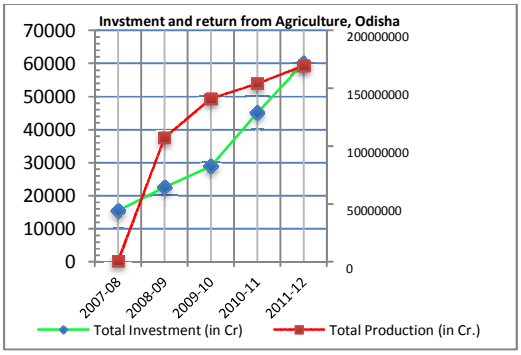


Figure. 2 Investment and Return from Agriculture, Odisha

situation, simulated with incomplete available data. Agriculture being mostly unpredictable, FL is the best tool for the researchers to compute the final output with great accuracy. The robust mechanism to compute accurate output without many vital inputs is the specialty of this technique ([20],[18],[23],[26]). FL has been selected as the tools in present study due to these inherent qualities.

Cost optimization under varying inputs, control of agricultural inputs for best use of the irrigation, drainage, fertilization and management of water has been the topic of the researchers ([10], [15], [19]). FL has been used in similar situation to compute the exact output required for inputs on real time mode. This study aims at determining the need of the numbers of rice mills to be promoted through the state as well as the central government for value addition to paddy and positioning the paddy produced in Odisha in global market. The paddy produced in Odisha has never been planned in this manner before ([16], [24]). The department of agriculture and food production helps and promotes to produce more and

more paddy through varying high tech inputs and proven technology. The civil supply department keeps the record of rice mills, storage space and provides raw material quota to individual rice mill for a calendar year. Department of industry keeps the eye on registration of all the rice mills of Odisha. The future role and goal of rice mills are never thought up of and planning has never been made in the light to make the presence of Odisha felt globally by any of the departments separately or jointly.

Zero budget planning is used in agriculture department for production of paddy and other crops. Figure. 2. provides the facts on input and output from agricultural sector. More and more scientific management, artificial intelligence logics must be used to preserve the produces. The wastage from such industry amounts to more than 35 percent in perishables crops ([34]) and about 24-26 percent for non-perishable crops. In case of non-perishable crops the losses during value addition is more. Rice hullers are presently used in rural areas for paddy milling produces about 70-90 % broken rice. This degrades the value of rice ([35]). Similarly the latest rice mills with modern rice milling technology have 2-4 % broken (Raw Rice milling) ([20], R.D. Archibald, Managing High-Technology Programs and Projects, John Wiley, New York, 1976., [36]).
Attempt has not been made in this direction to compute the need of the modern rice mills for value addition of rice and link the product produced in excess to export market to make the paddy cultivation best remunerative rather than accepting the false fact “paddy cultivation is not remunerative”. With increasing demand for organic rice, non-polished rice, processing and certification must be mooted to make it more profitable and acceptable to upcoming educated farming community.

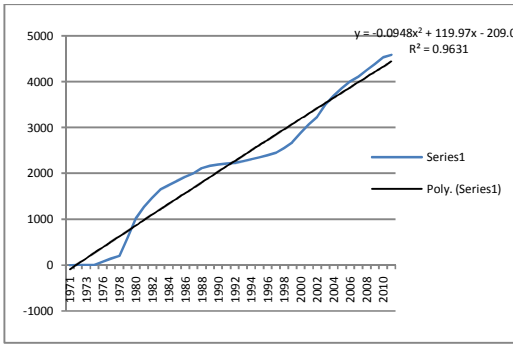


Figure 3 Trend of rice mills, Orissa

3. Research Methodology

The growth of modern rice mill population and modernization of the rice mills through government policy has been modeled under this R&D program. The inputs considered are paddy productivity, variation in paddy productivity, paddy type, present rice mill population, its technology and geographical locations. The actual data from the field are collected and plotted using the Excel / SPSS package and the trend analysis has been made. These trends are used in the input curve rule of FL model; it’s lower and upper limit in the input and output rules so that the real time simulation is realistic one.

Data are collected from DA&FP (O), Economics and statistics department, Government of India, Civil supplies Department and Department of Industries. All the parameters are analyzed using EXCEL package and SPSS Package. These data trend are extremely important for FL formation. The accuracy of the FL model depends upon the realistic input facts.

The factors responsible for growth of rice mills are considered in the simulation model and the rules are formed. Actual field conditions are also entered in to the model as obtained from the firsthand information sources like the rice millers of Odisha. The rule matrix is formed and the output is obtained for use by the planner of the government as well as the company personnel.

The rice production trend is not linear one it has been observed that the trend is a polynomial one with order 2 and regression coefficient 0.6. The marketing of the rice mill, seed replacement trend, surplus trend, procurement trends are important for formulation of the FL rules.

4. Model Formulation

The marketing of modern rice mill through strategy under government intervention has been formulated. To begin with the basic facts as mentioned above over time have been considered as the basic facts for formulation of developmental feasibility in real time mode. The trend analysis of the paddy milling plant

numbers and procurement has been shown in Figure 3. The best fit model out of all the combinations has been examined considering the highest r^2 value of the regression model. The growth trend of the rice

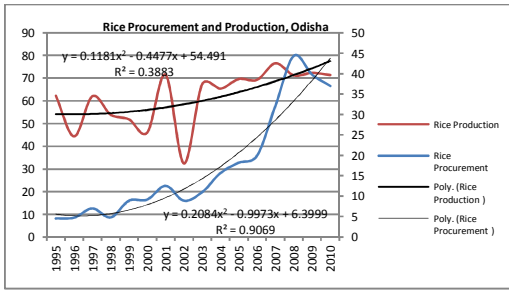


Figure 4 Rice productions and procurement, Odisha

procurement has been found out to be 0.96 (r^2). Similar analysis has been done for the paddy production. It has been found out that the paddy production trend is in consistent with r^2 value as 0.39.

These equations trends are used for selecting the fuzzy logic rule curve for finding out the requirement of new modern rice mill numbers under varying input

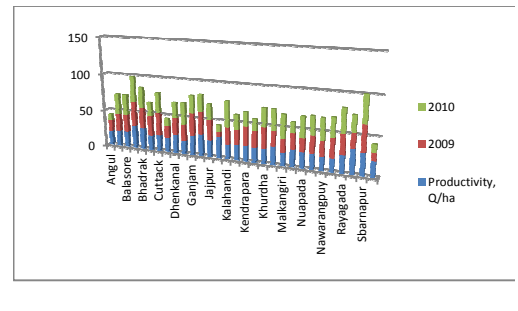


Figure 5 Variation of paddy productivity, Odisha

parameters. The primary data from the directorate of industries about the number of mills promoted and registered since 1970 till date are collected and the cumulative data are plotted for trend analysis. The best fitting curve has been determined Figure 4.

Till date about 4600 rice mills have been promoted

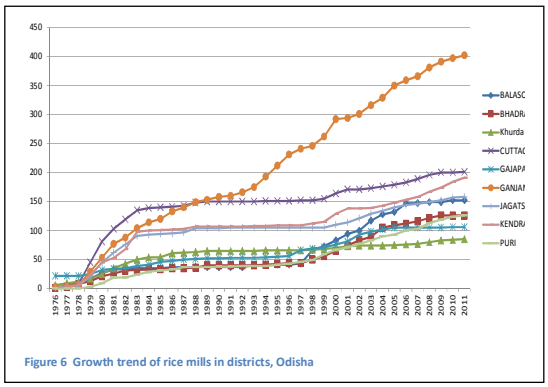


Figure 6 Growth trend of rice mills in districts, Odisha

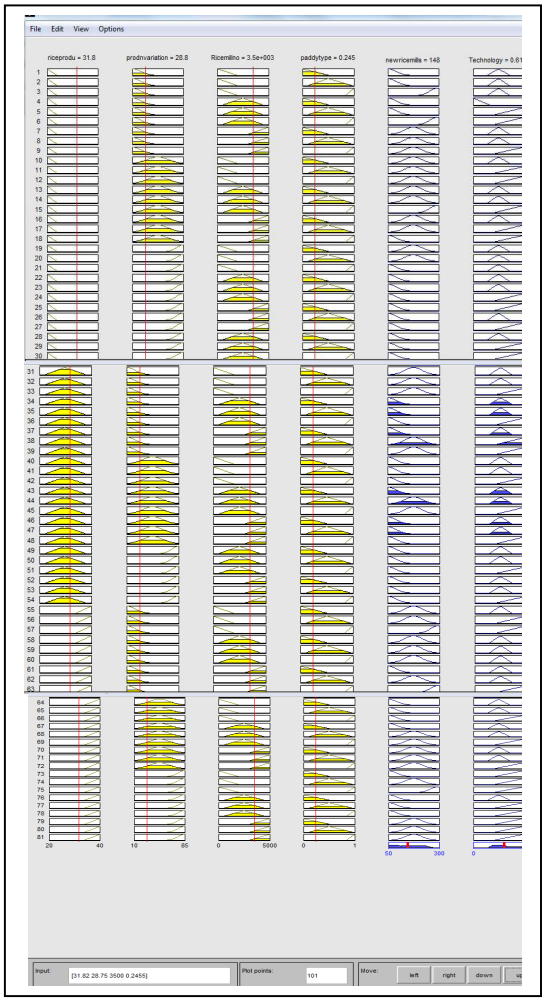
since 1971. The input values are given the trend and upper and lower limits are observed under real situation so that the real time projection is determined.

During computing the growth trend of paddy, generally a target growth is given for every year. Present trend in terms of percentage of rice procured over year has been computed and plotted to see that the projection can be made. Higher growth rate can be planned for increasing the implementation efficiency.

The change in the paddy production may hamper the rice mill performance and economic viability. The variation in paddy production in addition to productivity has been plotted. It has been found out that the variation of paddy productivity is less in coastal area compared to the in- land areas Figure .

Three years data (2008, 2009, 2010) have been plotted in a stacked format to see if there is any variation in paddy productivity. It has been observed that the paddy productivity is almost stable in coastal areas compared to the inland areas of Odisha. It implies in FL input this parameter can be made as a linearly variable to simulate the location specific rice mill development feasible for the proposed year.

Some of the districts of Odisha have been considered for determination of the growth trend. It is observed that all the districts have positive growth rate. District like Ganjam has high growth rate compared to lesser growth in other districts. The establishment of rice mill in other districts can be improved by providing government support in form of rice procurement and making the paddy available to the rice mills for



milling.

The registered rice mill number, functional rice mills under government patronage and scope of new upcoming modern rice mills have been computed. These values are cross checked with the numbers of rice mill which has feasibility determined through other computation methods. Figure 8. It has been further seen from the plotting of the trend of rice mill installation in different districts of Odisha that the trend has almost flat slope rather than in one district named Ganjam Figure 8. Considering the capacity of the paddy mill as 4 tons per Hour (TPH) on the same graph the present fact from Directorate of industries, civil supplies department and the theoretical numbers of possible rice mills as per rice production / procurement has been plotted, this curve shows there is a gap in the present level. The rice mills needs up-gradation and also more new rice mills can be promoted in the districts for best rice milling for the farmers.

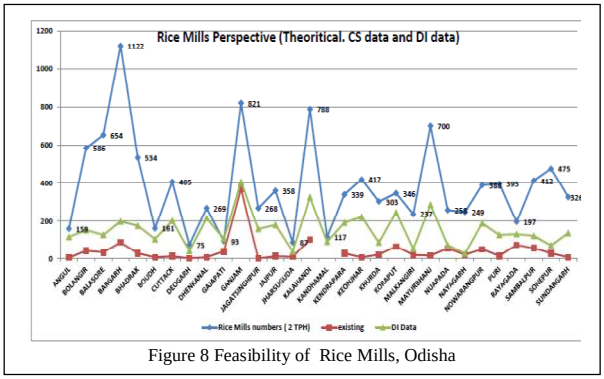


Figure 8 Feasibility of Rice Mills, Odisha

All above analysis are the input for the development of the FL for the policy drafting. Stand process of FL development has been used and through the

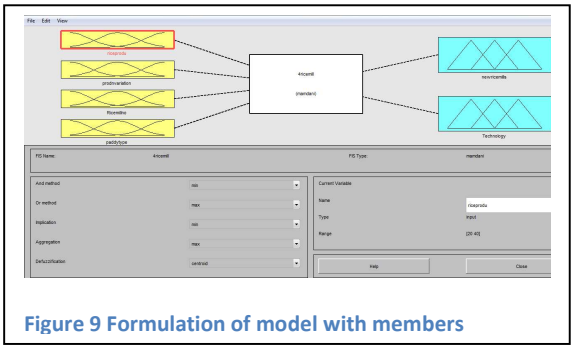


Figure 9 Formulation of model with members

MATLAB R2011b it has been analyzed. The results are taken out for analysis and interpretation. These findings may be used for farming policy for marketing of the rice mill in Odisha and frame it's logistic framework.

5. Model Validation

The trend analysis has been performed considering 40 years data on promotion of rice mill in Odisha since 1971. The projected figures shows that the numbers of rice mill to be promoted in coming year is 160 numbers considering average facts of Rice variety, Production, rice mill availability. It has been observed that the numbers of rice mills should be

promoted with more medium grain paddy cultivation, medium rain fall and numbers of rice mill present comes to be 147. This is well within the error (8%) against the limit of ± 10%. The prediction never considers the variation of input parameters. FL based estimation considers real time data and the results are more accurate than the forecasting method.

6. Formulation of Fuzzy Logic with MATLAB R2011b

In this research, three different parameters are considered to determine the future demand of the rice mills in Odisha depending upon present data. Forty years data of rice mill in Odisha are collected from the enlisted database with Permanent Registration Certificate issued by the department of industries, Odisha. They are found to be related with rice production of the area, type of paddy produced and its share, percentage of procurement promoted by government. In addition to this the area terrain, numbers of rice mill already operational in that area are other major parameters. FL has been formulated considering all above mentioned inputs and its effect on numbers of rice mill that may be promoted in the state. The suitability of types of rice mills like low cost, medium cost of high cost rice mills will be computed for the area depending upon the input parameters.

Four input parameters like Production, Product variation, numbers of rice mills and paddy type have been considered as the input membership function. The trend line has been considered while selecting the trend curves of the input variation. Similarly, the output function has been formulated considering parameters like time of year and rice mill marketing along with the technology level of the rice mills to be promoted for best result.

The input members and output members are linked using 81 knowledge based rules. These rules spell out the output under varying input conditions. There are three level of each input. All four inputs have three variation steps. These four inputs can combine in 81 ways. For each condition there is a definite solution considering the views of the expert's opinion. The same has been plotted in the Figure 7.

The paddy production variation has been considered to vary between 20 T to 40 T per Hectare. The variation in the production has been computed to lie between 10% - 85%. This has been used to frame the second input function. The numbers of rice mills are 4600 in numbers. Hence the range has been fixed to be between 0 - 5000.

The use of superfine seed for paddy production and harvest has been considered. It has been observed that there is variation in selecting paddy seed of commercial importance. All these 81 rules are framed and the expert's opinions on outputs are feed to the rule matrix. The model is used to solve for all crisp output. These outputs will be used in drafting the rice mill promotion policy and the company will use it for the production and marketing of such rice mills. This will bring synergy in the field of rice processing.

The relationship of the input parameters in 3D format has been used to formulate the rules. It has been observed that the costly imported rice mills are mostly suitable for area where the fine grain paddy is produced, the production of rice is more and government promotion is also there for more paddy procurement. The promoters engaged in rice export will prefer costly rice mill as such rice mills produce better and less broken clean polished shorted rice suitable for international market. The incentive from APEDA for installation of color shorting machine has been studied and found out that they are popular in western Odisha as the awareness is more compared to coastal region. More awareness among the rice millers will help in implementing the proposed marketing policy for development of rice milling in Odisha.

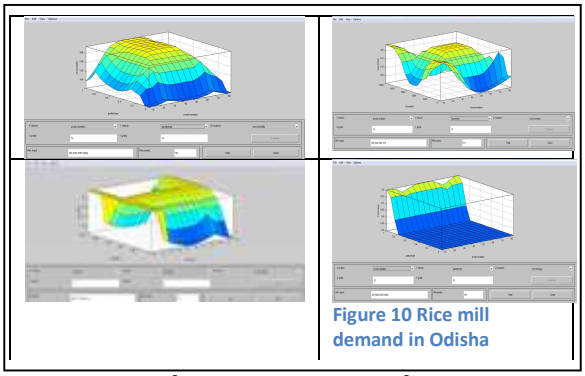


Figure 10 Rice mill demand in Odisha

The demand of rice mills under different condition are to be combined. It has been observed that the

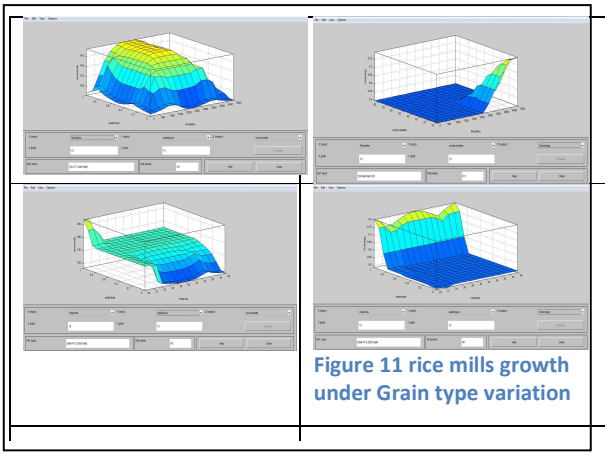


Figure 11 rice mills growth under Grain type variation

growth rate of numbers of rice mill is linear one. The production of paddy is linear one with low slopes. The procurement target has been increasing in a polynomial pattern. The adaptation of short grain, medium grain rice and long grain paddy is linear. Type of paddy grown in different terrain has been considered as a linear function (this is less variation in the variety of paddy cultivated traditionally). All these input functions are combined to give single crisp output for implementation. It has been observed that the trend analysis, simple arithmetic computation and FL crisp function output are very close to each other and are compatible. It gives the confirmation that FL can be suitable implemented for drafting the target for the year based on current real time data. Other techniques cannot deliver under such varying situation. While developing the rules the outputs are also examined. It is seen that even with insufficient inputs the target for rice mill marketing for the year is computed and are fairly correct. With sufficient input condition it performs better.

Attempts must be made to incorporate more rules so that the output is more accurate. The in- between facts are well computed with this model.

7. Interpretation of Results and Discussions

The output membership functions are defined as new rice mills and technology it will use. These two outputs are very much relevant with respect to marketing of the rice mills in Odisha Figure 3. Paddy production variations along with paddy type (Small, Medium, Long) have been treated as a measure to know about numbers of rice mill to be promoted in future with latest technology (Indian/imported). The second figure in figure 11 shows the variation of numbers of new rice mill to be promoted to mill 80% of the paddy produced as a function of variation of

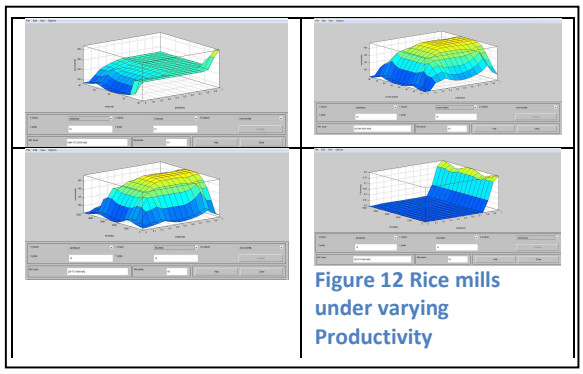


Figure 12 Rice mills under varying Productivity

production and numbers of rice mill promoted as on date from the year 1971. This graph shows facts that the variation is nonlinear and shows a pattern. It can be followed by the rice mill manufacturers. The numbers of rice mills and present production has been used to determine and predict the numbers of new rice mill to be promoted for sustainable rice production and value addition. This prediction is quite complex. One has to use these rules for development of the rice mills in Odisha for value addition. The last curve on the group shows the need of technology as a function of the product variation and the paddy type. Finer paddy production is the basis for high tech rice mill promotion. For sustainability of the rice mills with latest machinery the basis is super fine paddy and rice productivity. The clusters of such paddy production are the site for modern imported rice mills. The rice mill manufacturers must en-cash this curve and produce and market the modern rice mill for sustainability.

Paddy type, number of rice mills at present in the locality influences the future rice mill of that area to a great extent. The variation has been shown in the first quarter of the Figure 12. The trend is low pace at boundary condition where as high at middle value area. The medium located rice mill areas are suitable for future rice mill business. Similarly the high tech rice mill slots in Odisha context has been computed

from the model. It is clear from the model computation output that the high super fine paddy growing area, less variation in paddy production and more paddy production are index for modern rice mill promotion. The output is unique and gives understanding about the modern rice mill business in

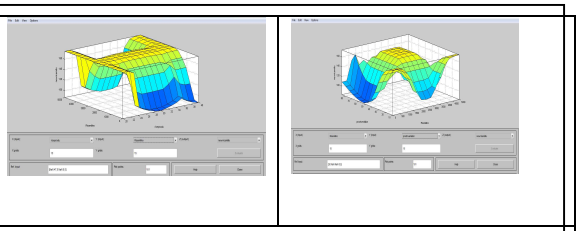


Figure 13 Rice technology under varying production and numbers of rice mills

Odisha. Figures in second, third and fourth quadrant reflects the above results.

The paddy production, variation in paddy production, paddy type and number of rice mills have been considered as the basis for determining the numbers of rice mills which can be safely promoted in Odisha state. The variation of the new rice mills which can be safely promoted under Odisha industrial climate has been given below Figure 13. This combination deals with effect of numbers of rice mills, variation of rice production and its effect on the new rice mill promotion. The number of rice mills possible to be promoted as a smart goal has been determined. The combinations with increase of the variables will increase the accuracy and reliability of the prediction. Present study suggests the variation in paddy seed to be made and earmarked to produce desired paddy for processing.

8. Conclusion

Rice mill up- gradation and installation of new modern rice mill in Odisha will produce rice of national as well as international standard. The slow procurement and marketing problems associated with rice will be solved permanently with increase of rice mills in strategic places with calculated manner. The logistics associated with procurement of rice mills and paddy can be developed. The rice mill manufacturers must come forward and use incentives available under Government of Odisha and Government of India schemes for successful implementation of these programs. About, 100 - 147 new modern rice mills of 4 TPH capacity can be promoted per year during 2012-13 with present rice production in Odisha. It can go up to 300 if more area of paddy crops is taken in Odisha in Rabi as well as Kharif season as presently prevalent in western Odisha. The rice growing in Odisha which is inevitable can be converted to strength than branded as weakness. This will provide business of INR 1000 crores in setting up new modern rice mills in Odisha. The rice processed through such mills will worth about $44.7 billion. Suitable plan logistic for such a rice production / processing orientation is desirable for development of common paddy growing farmers of Odisha. The need based real time data base can be used by the planner for earmarking subsidy for promotion of rice mills in Odisha. Presently the planning is not having any concrete base but with this model development can use latest logistics concepts and achieve the target which is the need of the hour for developing countries.

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